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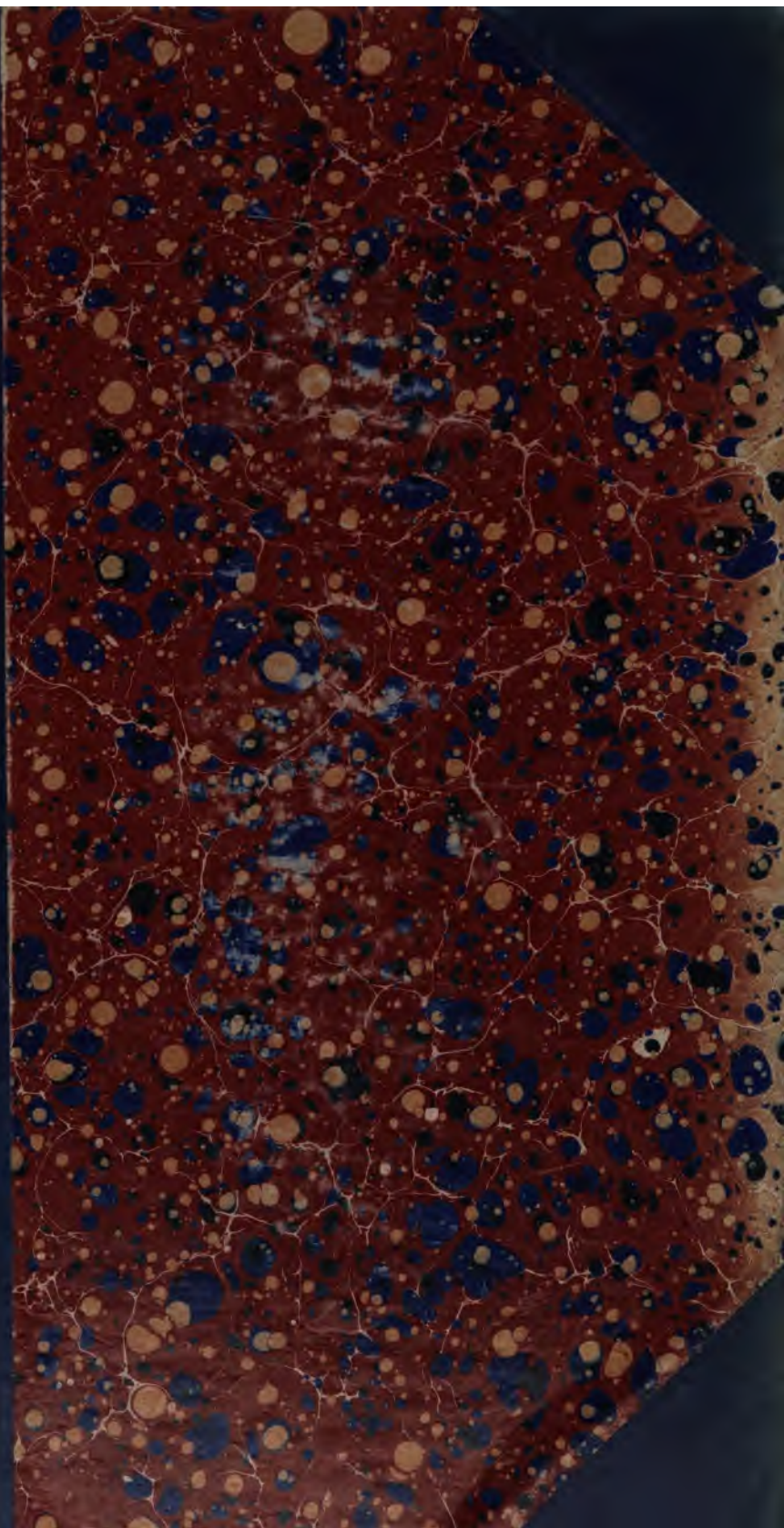
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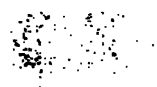
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THE OBSERVATORY,

A

MONTHLY REVIEW OF ASTRONOMY.

EDITED BY

T. LEWIS, F.R.A.S.,
H. P. HOLLIS, B.A., F.R.A.S.

VOL. XXI.

LONDON:

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

1898.

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ANNUAL COMPANION

TO

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

No. 261.

1898.

VOL. XXI.

INTRODUCTION.

THE present 'Companion' closely resembles that of last year.

As in former years, we have to thank Mr. Denning for revising the "Meteor Notes," and Mr. Maw for kindly supplying a number of observations of Double Stars.

M. Loewy has again favoured us with advance-proofs from which we have obtained the Variable Star Ephemerides. The occultations and phenomena of Jupiter's Satellites are from the 'Nautical Almanac'; the diagrams and Ephemerides of the Satellites of the other planets from the 'American Ephemeris.'

We are indebted to Mr. Crommelin for the list of stars to be occulted by the Moon (as seen from Greenwich) during the lunar eclipses of July 3 and December 27.

The "Fraction of the Year" is the fraction which has elapsed at mean noon of the particular day from mean noon on January 1. The Moon's declination is given for mean midnight. The "Longitude of the Moon's Terminator" is given for mean midnight; the letters M. and E. signifying morning and evening—that is, that the Sun is rising or setting on that particular longitude of the Moon's surface; the sign + indicates longitudes reckoned from the central meridian in a westward direction. The angles of disappearance and reappearance for occultations are reckoned from the *true* north in the direction N. E. S. W., as for double stars.

Greenwich Mean Time is used in all cases, and the astronomical day is reckoned from noon to noon as in previous years.

VOL. XXI.

B

Date.	Day of Year.	Fr. of Year.	Sun		☉'s Dec. Noon.	M.T. at Apparent Noon.	Sid. T. at Mean Noon.	Moon's Phases.
			Sets.	Rises.				
			h m	h m	° ' "	h m s	h m s	d h m
Jan. 2	2	'003	4 1	20 8	22 54 S	0 4 23	18 48 35	○ 7 12 24
9	9	'022	4 10	20 4	22 4	7 27	19 16 10	☾ 15 3 45
16	16	'041	4 21	20 0	20 53	10 5	19 43 46	● 21 19 25
23	23	'060	4 32	19 51	19 22	12 9	20 11 22	☾ 29 2 33
30	30	'079	4 44	19 43	17 34	13 34	20 38 58	
Feb. 6	37	'099	4 57	19 29	15 31	14 19	21 6 34	○ 6 6 24
13	44	'118	5 9	19 17	13 15	14 24	21 34 10	☾ 13 12 35
20	51	'137	5 23	19 3	10 48	13 54	22 1 46	● 20 7 41
27	58	'156	5 34	18 49	8 13	12 52	22 29 22	☾ 27 23 13
Mar. 6	65	'175	5 46	18 34	5 32	11 23	22 56 58	○ 7 21 29
13	72	'194	5 59	18 17	2 48	9 33	23 24 33	☾ 14 19 48
20	79	'214	6 11	18 1	0 2 S	7 31	23 52 9	● 21 20 37
27	86	'233	6 23	17 47	2 43 N	5 24	0 19 45	☾ 29 19 40
April 3	93	'252	6 34	17 30	5 26	3 16	0 47 21	○ 6 9 20
10	100	'271	6 45	17 15	8 4	0 1 16	1 14 57	☾ 13 2 28
17	107	'290	6 58	17 0	10 35	23 59 29	1 42 33	● 20 10 21
24	114	'309	7 10	16 45	12 58	58 2	2 10 9	☾ 28 14 5
May 1	121	'329	7 21	16 31	15 10	56 58	2 37 45	○ 5 18 34
8	128	'348	7 32	16 18	17 10	56 19	3 5 20	☾ 12 9 36
15	135	'367	7 43	16 8	18 56	56 9	3 32 56	● 20 0 58
21	142	'386	7 52	15 59	20 27	56 27	4 0 32	☾ 28 5 14
29	149	'405	8 2	15 51	21 40	57 10	4 28 8	
June 5	156	'424	8 9	15 47	22 35	58 14	4 55 44	○ 4 2 11
12	163	'444	8 14	15 44	23 11	59 35	5 23 20	☾ 10 18 4
19	170	'463	8 18	15 43	23 26	0 1 4	5 50 56	● 18 16 19
26	177	'482	8 19	15 46	23 22	2 35	6 18 32	☾ 26 16 54
July 3	184	'501	8 17	15 50	22 57	3 58	6 46 8	○ 3 9 12
10	191	'520	8 14	15 57	22 13	5 6	7 13 44	☾ 10 4 43
17	198	'539	8 7	16 7	21 10	5 54	7 41 19	● 18 7 47
24	205	'559	7 58	16 14	19 50	6 16	8 8 55	☾ 26 1 40
31	212	'578	7 48	16 26	18 13	6 9	8 36 31	
Aug. 7	219	'597	7 36	16 35	16 22	5 32	9 4 7	○ 1 16 29
14	226	'616	7 23	16 45	14 17	4 28	9 31 43	☾ 8 18 13
21	233	'635	7 9	16 58	12 2	2 57	9 59 19	● 16 22 35
28	240	'654	6 55	17 9	9 37	0 1 4	10 26 55	☾ 24 8 32
Sept. 4	247	'674	6 39	17 21	7 5	23 58 52	10 54 31	○ 31 0 51
11	254	'693	6 23	17 32	4 27	56 30	11 22 7	☾ 7 10 51
18	261	'712	6 7	17 43	1 46 N	54 3	11 49 42	● 15 12 10
25	268	'731	5 51	17 53	0 58 S	51 36	12 17 18	☾ 22 14 39
Oct. 2	275	'750	5 34	18 6	3 41	49 18	12 44 54	○ 29 11 11
9	282	'769	5 19	18 18	6 23	47 15	13 12 30	☾ 7 6 5
16	289	'789	5 3	18 29	9 0	45 35	13 40 6	● 15 0 37
23	296	'808	4 48	18 42	11 31	44 24	14 7 42	☾ 21 21 9
30	303	'827	4 36	18 54	13 54	43 45	14 35 18	○ 29 0 18
Nov. 6	310	'846	4 24	19 6	16 5	43 45	15 2 54	☾ 6 2 28
13	317	'865	4 12	19 19	18 4	44 27	15 30 29	○ 13 12 21
20	324	'884	4 3	19 30	19 47	45 49	15 58 5	☾ 20 5 5
27	331	'904	3 56	19 41	21 12	47 51	16 25 41	○ 27 16 39
Dec. 4	338	'923	3 51	19 52	22 18	50 27	16 53 17	☾ 5 22 6
11	345	'942	3 49	19 58	23 2	53 31	17 20 53	○ 12 23 43
18	352	'961	3 50	20 4	23 25	56 54	17 48 29	☾ 19 15 22
25	359	'980	3 54	20 7	23 24	0 0 23	18 16 5	○ 27 11 39
Jan. 1	366	'000	3 59	20 8	23 0 S	0 3 47	18 43 41	

For Moon's phases: ● signifies New; ☾ First Quarter; ○ Full; ☾ Last Quarter.

JANUARY.										FEBRUARY.										MARCH.										APRIL.									
Day.		Moon.				Day.		Moon.				Day.		Moon.				Day.		Moon.				Day.		Moon.													
Month.	Week.	Sets.	Souths.	Dec.	Long. of Terminator.	Month.	Week.	Sets.	Souths.	Dec.	Long. of Terminator.	Month.	Week.	Sets.	Souths.	Dec.	Long. of Terminator.	Month.	Week.	Sets.	Souths.	Dec.	Long. of Terminator.	Month.	Week.	Sets.	Souths.	Dec.	Long. of Terminator.										
1	S	h 15	h 8	7 13 18 30 N	-19° 8' M.	1	Tu	h 17	h 9	8 19 26 14 N	-36° 7' M.	1	Tu	h 15	h 7	7 25 51 N	-17° 4' M.	1	F	h 15	h 8	7 15 40 N	-35° 0' M.	1	F	h 15	h 8	7 15 40 N	-35° 0' M.										
2	S	h 16	h 18	7 58 21 58	-31° 9' M.	2	W	h 17	h 51	9 10 25 39	-48° 9' M.	2	W	h 16	h 24	7 52 34 30	-29° 6' M.	2	S	h 15	h 55	8 52 10 53	-47° 2' M.	2	S	h 15	h 55	8 52 10 53	-47° 2' M.										
3	M	h 17	h 24	8 46 24 29	-44° 1' M.	3	Tu	h 18	h 27	10 0 23 53	-61° 0' M.	3	Th	h 16	h 54	8 41 22 1	-41° 7' M.	3	M	h 16	h 11	9 37 5 30 N	-59° 4' M.	3	M	h 16	h 11	9 37 5 30 N	-59° 4' M.										
4	Tu	h 18	h 23	9 35 25 55	-56° 3' M.	4	F	h 18	h 52	10 49 21 53	-73° 2' M.	4	F	h 17	h 15	9 29 18 31	-53° 9' M.	4	S	h 16	h 26	10 23 0 16 S	-71° 5' M.	4	S	h 16	h 26	10 23 0 16 S	-71° 5' M.										
5	W	h 19	h 14	10 26 26 11	-68° 4' M.	5	S	h 19	h 12	11 37 17 8	-85° 4' M.	5	S	h 17	h 35	10 16 14 7	-66° 1' M.	5	Tu	h 16	h 41	11 10 6 11	-83° 7' M.	5	Tu	h 16	h 41	11 10 6 11	-83° 7' M.										
6	Th	h 19	h 53	11 17 25 15	-80° 5' M.	6	S	h 19	h 12	12 12 12 8	-82° 5' E.	6	S	h 17	h 51	11 1 9 0	-78° 3' M.	6	W	h 16	h 41	11 10 6 11	-83° 7' M.	6	W	h 16	h 41	11 10 6 11	-83° 7' M.										
7	F	h 20	h 12	12 12 12 8	-87° 3' E.	7	M	h 20	h 12	7 7 11	+70° 3' E.	7	M	h 15	h 13	7 7 11	+70° 3' E.	7	Tu	h 18	h 12	12 12 12 8	-87° 3' E.	7	Tu	h 18	h 12	12 12 12 8	-87° 3' E.										
8	S	h 20	h 12	12 12 12 8	+75° 1' E.	8	Tu	h 21	h 13	7 4 19 S	+58° 1' E.	8	Tu	h 7	h 28	13 52 1 30 N	+58° 1' E.	8	F	h 18	h 12	12 12 12 8	-87° 3' E.	8	F	h 18	h 12	12 12 12 8	-87° 3' E.										
9	S	h 21	h 13	13 1 15 52	+62° 9' E.	9	W	h 21	h 13	4 19 S	+46° 0' E.	9	W	h 8	h 46	14 37 4 19 S	+46° 0' E.	9	S	h 19	h 14	9 37 5 30 N	-59° 4' M.	9	S	h 19	h 14	9 37 5 30 N	-59° 4' M.										
10	S	h 21	h 13	13 1 15 52	+50° 8' E.	10	Th	h 21	h 13	10 5 15 24 10 2	+33° 8' E.	10	Th	h 10	h 51	5 24 10 2	+33° 8' E.	10	M	h 19	h 11	9 37 5 30 N	-59° 4' M.	10	M	h 19	h 11	9 37 5 30 N	-59° 4' M.										
11	Tu	h 22	h 14	14 1 15 52	+38° 6' E.	11	F	h 22	h 14	11 26 10 15 21	+21° 6' E.	11	F	h 11	h 26	10 15 21	+21° 6' E.	11	Tu	h 20	h 10	9 37 5 30 N	-59° 4' M.	11	Tu	h 20	h 10	9 37 5 30 N	-59° 4' M.										
12	W	h 23	h 15	15 1 15 52	+26° 4' E.	12	S	h 23	h 15	12 49 17 6 19 57	+9° 5' E.	12	S	h 12	h 49	17 6 19 57	+9° 5' E.	12	W	h 21	h 8	10 35 15	+40° 8' E.	12	W	h 21	h 8	10 35 15	+40° 8' E.										
13	Th	h 24	h 16	16 1 15 52	+14° 3' E.	13	M	h 24	h 16	14 12 18 4 23 30	-2° 7' E.	13	M	h 14	h 12	18 4 23 30	-2° 7' E.	13	Tu	h 22	h 6	11 59 15	+59° 22' 38	13	Tu	h 22	h 6	11 59 15	+59° 22' 38										
14	F	h 25	h 17	17 1 15 52	+2° 2' E.	14	Tu	h 25	h 17	15 30 19 4 25 39	-14° 9' E.	14	Tu	h 15	h 30	19 4 25 39	-14° 9' E.	14	W	h 23	h 4	12 16 18	+59° 25' 7	14	W	h 23	h 4	12 16 18	+59° 25' 7										
15	S	h 26	h 18	18 1 15 52	-10° 0' E.	15	W	h 26	h 18	16 33 20 7 26 9	-27° 1' E.	15	W	h 16	h 33	20 7 26 9	-27° 1' E.	15	Tu	h 24	h 2	13 18 19	+43° 3' E.	15	Tu	h 24	h 2	13 18 19	+43° 3' E.										
16	S	h 27	h 19	19 1 15 52	-22° 2' E.	16	Th	h 27	h 19	17 21 21 8 24 54	-39° 2' E.	16	Th	h 17	h 21	21 8 24 54	-39° 2' E.	16	W	h 25	h 0	14 19 21	+79° 5' E.	16	W	h 25	h 0	14 19 21	+79° 5' E.										
17	M	h 28	h 20	20 1 15 52	-34° 3' E.	17	Tu	h 28	h 20	17 58 22 7 22 1	-51° 4' E.	17	Tu	h 17	h 58	22 7 22 1	-51° 4' E.	17	W	h 26	h 1	15 18 19	+125° 11	17	W	h 26	h 1	15 18 19	+125° 11										
18	Tu	h 29	h 21	21 1 15 52	-46° 5' E.	18	F	h 29	h 21	18 23 23 2 17 47	-63° 6' E.	18	F	h 18	h 23	23 2 17 47	-63° 6' E.	18	Tu	h 27	h 3	16 20 20	+54° 19' 14	18	Tu	h 27	h 3	16 20 20	+54° 19' 14										
19	W	h 30	h 22	22 1 15 52	-58° 6' E.	19	S	h 30	h 22	19 23 23 54 12 34	-75° 7' E.	19	S	h 18	h 23	23 54 12 34	-75° 7' E.	19	W	h 28	h 5	17 20 23	+20° 1 E.	19	W	h 28	h 5	17 20 23	+20° 1 E.										
20	Th	h 31	h 23	23 1 15 52	-70° 8' E.	20	S	h 31	h 23	20 23 23 54 12 34	-87° 9' E.	20	S	h 20	h 23	23 54 12 34	-87° 9' E.	20	Tu	h 29	h 7	18 21 21	+44° 14	20	Tu	h 29	h 7	18 21 21	+44° 14										
21	F	h 32	h 24	24 1 15 52	-83° 0' E.	21	M	h 32	h 24	21 23 23 54 12 34	-94° 3' M.	21	M	h 6	h 41	0 42 0 47 8	-80° 9' E.	21	W	h 30	h 9	19 22 34	+8° 45	21	W	h 30	h 9	19 22 34	+8° 45										
22	S	h 33	h 25	25 1 15 52	-94° 3' M.	22	Tu	h 33	h 25	22 23 23 54 12 34	-106° 5' M.	22	Tu	h 8	h 1	28 5 6 N	-67° 8' M.	22	W	h 31	h 11	20 23 20	+2° 56' 8	22	W	h 31	h 11	20 23 20	+2° 56' 8										
23	S	h 34	h 26	26 1 15 52	-106° 5' M.	23	W	h 34	h 26	23 23 23 54 12 34	-118° 7' M.	23	W	h 9	h 16	2 14 10 37	+55° 6' M.	23	Tu	h 32	h 13	21 24 10	+31° 3' M.	23	Tu	h 32	h 13	21 24 10	+31° 3' M.										
24	Tu	h 35	h 27	27 1 15 52	-118° 7' M.	24	Th	h 35	h 27	24 23 23 54 12 34	-130° 9' M.	24	Th	h 10	h 31	2 59 15 31	+43° 5' M.	24	W	h 33	h 15	22 25 11	+42° 4' M.	24	W	h 33	h 15	22 25 11	+42° 4' M.										
25	W	h 36	h 28	28 1 15 52	-130° 9' M.	25	F	h 36	h 28	25 23 23 54 12 34	-142° 1' M.	25	F	h 11	h 45	3 45 19 39	+31° 3' M.	25	Tu	h 34	h 17	23 26 11	+50° 3' M.	25	Tu	h 34	h 17	23 26 11	+50° 3' M.										
26	Th	h 37	h 29	29 1 15 52	-142° 1' M.	26	S	h 37	h 29	26 23 23 54 12 34	-154° 3' M.	26	S	h 12	h 56	4 32 22 51	+19° 1' M.	26	W	h 35	h 19	24 27 12	+58° 1' M.	26	W	h 35	h 19	24 27 12	+58° 1' M.										
27	F	h 38	h 30	30 1 15 52	-154° 3' M.	27	S	h 38	h 30	27 23 23 54 12 34	-166° 5' M.	27	S	h 14	h 2	5 21 25 1	+7° 0' M.	27	Tu	h 36	h 21	25 28 13	+66° 0' M.	27	Tu	h 36	h 21	25 28 13	+66° 0' M.										
28	S	h 39	h 31	31 1 15 52	-166° 5' M.	28	M	h 39	h 31	28 23 23 54 12 34	-178° 7' M.	28	M	h 14	h 59	6 11 26 2 N	+5° 2' M.	28	W	h 37	h 23	26 29 14	+74° 8' M.	28	W	h 37	h 23	26 29 14	+74° 8' M.										
29	S	h 40	h 32	32 1 15 52	-178° 7' M.	29	W	h 40	h 32	29 23 23 54 12 34	-190° 9' M.	29	W	h 14	h 51	6 43 24 52	+1° 6' M.	29	Tu	h 38	h 25	27 30 15	+82° 9' E.	29	Tu	h 38	h 25	27 30 15	+82° 9' E.										
30	M	h 41	h 33	33 1 15 52	-190° 9' M.	30	Th	h 41	h 33	30 23 23 54 12 34	-202° 1' M.	30	Th	h 15	h 18	6 32 22 47	+10° 7' M.	30	Tu	h 39	h 27	28 31 16	+90° 9' E.	30	Tu	h 39	h 27	28 31 16	+90° 9' E.										
31	S	h 42	h 34	34 1 15 52	-202° 1' M.	31	F	h 42	h 34	31 23 23 54 12 34	-214° 3' M.	31	F	h 15	h 18	6 32 22 47	+10° 7' M.	31	W	h 40	h 29	29 32 17	+98° 1' E.	31	W	h 40	h 29	29 32 17	+98° 1' E.										

MAY.					JUNE.					JULY.					AUGUST.				
Day.		Moon.			Day.		Moon.			Day.		Moon.			Day.		Moon.		
Month.	Week.	Sets.	Souths.	Dec.	Long. of Terminator.	Month.	Week.	Sets.	Souths.	Dec.	Long. of Terminator.	Month.	Week.	Sets.	Souths.	Dec.	Long. of Terminator.		
1	S	14 30	8 13	1 54 N	-41° 0' M.	1	W	13 47	9 16	17 57 S	-59° 6' M.	1	F	13 41	10 05	23 S	-66° 3' M.		
2	M	14 44	8 59	3 53 S	-53° 2' M.	2	Th	14 18	10 14	21 59 S	-71° 8' M.	2	S	14 49	11 05	12	-78° 5' M.		
3	Tu	15 2	9 46	9 39	-65° 4' M.	3	F	15 3	11 17	24 38 S	-84° 0' M.	3	S	15 3	11 17	24 38 S	-84° 0' M.		
4	W	15 23	10 38	15 6	-77° 5' M.	4	S	15 23	12 32	25 31 S	+83° 7' E.	4	M	8 54	13 13	19 25 S	+89° 3' E.		
5	Th	15 50	11 34	19 49	-89° 7' M.	5	S	9 43	13 29	24 30 S	+71° 5' E.	5	Tu	9 22	14 10	14 30 S	+77° 1' E.		
6	F	15 57	12 38	23 20	-78° 0' E.	6	M	10 57	15 30	17 32 S	+59° 3' E.	6	W	9 43	15 3	8 51 S	+64° 9' E.		
7	S	9 57	13 38	25 17	+65° 8' E.	7	Tu	10 57	15 30	17 32 S	+47° 1' E.	7	Th	10 15	52	2 55 S	+52° 7' E.		
8	M	11 4	14 43	25 24	+53° 6' E.	8	W	11 20	16 23	12 25 S	+34° 9' E.	8	F	10 16	16 38	2 58 N	+40° 5' E.		
9	Tu	11 55	15 46	23 44	+41° 4' E.	9	Th	11 39	17 12	6 48 S	+22° 7' E.	9	S	10 32	17 24	8 32 S	+16° 1' E.		
10	W	12 29	16 45	20 30	+29° 2' E.	10	F	11 54	17 58	1 28 S	+10° 5' E.	10	S	10 50	18	9 13 34 S	+3° 8' E.		
11	Th	12 55	17 39	16 8	+17° 0' E.	11	S	12 9	18 43	4 37 N	-1° 8' E.	11	M	11 8	18	5 17 53 S	-8° 4' E.		
12	Th	13 16	18 29	10 59	+4° 8' E.	12	M	12 26	19 27	9 55 S	-14° 0' E.	12	Tu	11 33	19	44 21 21 S	-20° 6' E.		
13	F	13 34	19 15	5 27 S	-7° 5' E.	13	W	12 44	20 12	14 42 S	-26° 2' E.	13	W	12 30	33	53 51 S	-32° 8' E.		
14	S	13 47	20 0	0 13 N	-19° 7' E.	14	Tu	13 4	20	59 18 48 S	-38° 4' E.	14	Th	12 42	21	23 25 15 S	-45° 0' M.		
15	M	14 32	20 44	5 45	-31° 9' E.	15	W	13 29	21	47 22 2 S	-50° 6' E.	15	F	13 31	22	33 25 29 S	-57° 2' E.		
16	Tu	14 20	21 28	10 57	-44° 1' E.	16	Th	14 32	22	36 24 16 S	-62° 8' E.	16	S	14 48	23	24 35 S	-69° 5' E.		
17	W	14 37	22 15	37	-56° 3' E.	17	F	14 45	23	26 25 23 S	-74° 9' E.	17	S	15 34	23	50 22 35 S	-81° 8' E.		
18	Th	15 02	23 1	19 34	-68° 5' E.	18	S	15 37	23	25 21 S	-87° 1' E.	18	M	15 34	23	50 22 35 S	-81° 8' E.		
19	Th	15 23	23 50	22 37	-80° 7' E.	19	S	15 37	23	25 21 S	-87° 1' E.	19	Tu	8 15	20	15 45 S	+73° 7' M.		
20	F	8 24	24	24 37	+74° 8' M.	20	M	9 24	1	52 15 55 S	+68° 2' M.	20	W	8 33	1	50 15 45 S	+61° 4' M.		
21	S	9 23	0 40	25 29	+74° 8' M.	21	Tu	9 48	1	52 18 43 S	+56° 0' M.	21	Th	8 48	2	3 16 16 S	+40° 2' M.		
22	M	10 12	1 30	25 11	+62° 6' M.	22	W	10 8	2	38 14 44 S	+43° 8' M.	22	F	9 3	2	46 0 58 N	+37° 0' M.		
23	Tu	10 51	2 20	23 44	+50° 4' M.	23	Th	10 25	3	21 10 7 S	+19° 4' M.	23	S	9 17	3	28 4 27 S	+24° 5' M.		
24	W	11 20	3 8	21 15	+38° 0' M.	24	F	10 40	4	4 5 2 N	+7° 2' M.	24	M	9 33	4	12 9 48 S	+12° 6' M.		
25	Th	11 45	3 55	17 51	+26° 0' M.	25	S	10 56	4	46 0 20 S	-52° 2' M.	25	S	9 51	4	59 14 51 S	+0° 4' M.		
26	Th	12 2	4 40	13 41	+13° 8' M.	26	S	11 9	5	50 5 49 S	-52° 2' M.	26	Tu	10 15	5	49 19 17 S	+11° 9' M.		
27	S	12 20	5 23	8 55	+1° 6' M.	27	S	11 27	6	15 11 13 S	-17° 4' M.	27	W	10 44	6	44 22 46 S	-24° 1' M.		
28	F	12 34	6	3 40 N	-10° 8' M.	28	Th	11 46	7	16 14 S	-41° 8' M.	28	Th	11 26	8	45 25 29 S	-48° 5' M.		
29	S	12 49	6 50	1 52 S	-23° 0' M.	29	W	12 12	7	58 20 33 S	-41° 8' M.	29	F	12 26	8	45 25 29 S	-48° 5' M.		
30	M	13 4	7 35	7 31	-35° 2' M.	30	Th	12 49	8	57 23 44 S	-54° 0' M.	30	S	13 42	9	51 24 14 S	-60° 7' M.		

SEPTEMBER.					OCTOBER.					NOVEMBER.					DECEMBER.				
Day.		Moon.			Day.		Moon.			Day.		Moon.			Day.		Moon.		
Month.	Week.	Rises.	Souths.	Dec.	Long. of Terminator.	Month.	Week.	Rises.	Souths.	Dec.	Long. of Terminator.	Month.	Week.	Rises.	Souths.	Dec.	Long. of Terminator.	Month.	Week.
1	Th	6 41 13	5 4 2 N	+76° 2 E.	+76° 2 E.	1	S	5 41 13	20 17 17 N	+70° 2 E.	+70° 2 E.	1	Tu	5 56 14	34 24 51 N	+52° 5 E.	+52° 5 E.	1	Th
2	F	6 59 13	5 9 41	+64° 0 E.	+64° 0 E.	2	M	6 7 14	10 20 55	+58° 0 E.	+58° 0 E.	2	W	6 51 15	24 24 13	+40° 3 E.	+40° 3 E.	2	F
3	S	7 17 14	5 14 44	+51° 8 E.	+51° 8 E.	3	M	6 37 15	12 23 27	+45° 8 E.	+45° 8 E.	3	Th	7 51 16	13 22 29	+28° 1 E.	+28° 1 E.	3	S
4	S	7 39 15	30 18 57	+39° 5 E.	+39° 5 E.	4	Tu	7 16 15	52 24 49	+33° 5 E.	+33° 5 E.	4	F	8 56 17	0 19 47	+15° 9 E.	+15° 9 E.	4	S
5	M	8 6 16	20 22 11	+27° 3 E.	+27° 3 E.	5	W	8 4 16	43 24 59	+21° 3 E.	+21° 3 E.	5	S	10 6 17	44 16 17	+3° 3 E.	+3° 3 E.	5	M
6	Tu	8 39 17	10 24 18	+15° 1 E.	+15° 1 E.	6	Th	9 1 17	32 23 59	+9° 2 E.	+9° 2 E.	6	S	11 14 18	27 12 5	-8° 3 E.	-8° 3 E.	6	Tu
7	W	9 21 18	12 5 15	+2° 9 E.	+2° 9 E.	7	F	10 5 18	21 21 56	-2° 9 E.	-2° 9 E.	7	M	12 24 19	10 7 21	-20° 5 E.	-20° 5 E.	7	W
8	Th	10 12 18	5 12 5 2	-9° 3 E.	-9° 3 E.	8	S	11 13 19	6 18 57	-15° 1 E.	-15° 1 E.	8	W	13 33 19	53 2 14 N	-32° 7 E.	-32° 7 E.	8	Th
9	F	11 11 19	40 23 41	-21° 5 E.	-21° 5 E.	9	S	12 21 19	51 15 8	-27° 3 E.	-27° 3 E.	9	W	14 49 20	37 3 7 S	-44° 9 E.	-44° 9 E.	9	F
10	S	12 18 20	27 21 17	-33° 7 E.	-33° 7 E.	10	M	13 33 20	35 10 40	-39° 5 E.	-39° 5 E.	10	Th	16 4 21	24 8 29	-57° 1 E.	-57° 1 E.	10	S
11	M	13 26 21	13 17 57	-46° 0 E.	-46° 0 E.	11	Tu	14 43 21	18 5 41	-51° 7 E.	-51° 7 E.	11	F	17 24 22	14 13 37	-69° 3 E.	-69° 3 E.	11	M
12	Tu	14 39 21	57 13 51	-58° 2 E.	-58° 2 E.	12	W	15 55 22	2 0 21 N	-64° 0 E.	-64° 0 E.	12	S	18 47 23	9 18 12	-81° 5 E.	-81° 5 E.	12	Tu
13	W	15 49 22	41 9 7	-70° 4 E.	-70° 4 E.	13	Th	17 11 22	47 5 8 S	-76° 2 E.	-76° 2 E.	13	S	sets	.....	-86° 9 M.	-86° 9 M.	13	W
14	Th	17 1 23	24 3 55 N	-82° 6 E.	-82° 6 E.	14	F	18 29 23	36 10 32	-88° 4 E.	-88° 4 E.	14	M	4 3 0	8 24 7	-74° 7 M.	-74° 7 M.	14	Th
15	F	sets	.....	-85° 3 M.	-85° 3 M.	15	S	sets	.....	-88° 4 E.	-88° 4 E.	15	Tu	4 55 1	11 24 47	-62° 5 M.	-62° 5 M.	15	F
16	S	5 48 0	9 7 0	-73° 1 M.	-73° 1 M.	16	S	4 55 0	28 19 46	+67° 3 M.	+67° 3 M.	16	W	6 6 2	14 23 42	+50° 3 M.	+50° 3 M.	16	S
17	S	6 6 0	55 12 16	+60° 9 M.	+60° 9 M.	17	M	5 27 1	24 22 55	+55° 1 M.	+55° 1 M.	17	Th	7 25 3	16 21 2	+38° 1 M.	+38° 1 M.	17	S
18	M	6 27 1	43 17 1	+48° 7 M.	+48° 7 M.	18	Tu	6 27 1	24 22 55	+42° 9 M.	+42° 9 M.	18	F	8 19 4	15 17 4	+26° 0 M.	+26° 0 M.	18	M
19	Tu	6 53 2	35 20 56	+36° 5 M.	+36° 5 M.	19	W	7 8 2	23 24 39	+30° 7 M.	+30° 7 M.	19	S	10 43 5	9 12 11	+13° 8 M.	+13° 8 M.	19	Tu
20	W	7 26 3	31 23 43	+24° 3 M.	+24° 3 M.	20	Th	8 19 4	25 23 18	+18° 5 M.	+18° 5 M.	20	M	11 35 6	0 6 44	+1° 6 M.	+1° 6 M.	20	W
21	Th	8 12 4	30 25 4	+12° 1 M.	+12° 1 M.	21	F	9 38 5	24 20 20	+6° 4 M.	+6° 4 M.	21	Tu	12 53 6	48 1 5 S	-10° 8 M.	-10° 8 M.	21	Th
22	F	9 12 5	30 24 50	0° 0 M.	0° 0 M.	22	S	11 1 6	20 16 12	-5° 7 M.	-5° 7 M.	22	W	15 25 8	20 9 50	-23° 0 M.	-23° 0 M.	22	F
23	S	11 49 7	29 19 45	-24° 4 M.	-24° 4 M.	23	S	12 24 7	12 11 12	-17° 9 M.	-17° 9 M.	23	Th	16 41 9	7 14 37	-47° 4 M.	-47° 4 M.	23	S
24	S	13 14 8	24 15 18	-36° 6 M.	-36° 6 M.	24	M	13 45 8	2 5 41 S	-30° 1 M.	-30° 1 M.	24	F	17 54 9	55 18 40	-35° 2 M.	-35° 2 M.	24	Th
25	M	14 38 9	16 10 0	-48° 9 M.	-48° 9 M.	25	W	15 5 8	50 0 3 N	-42° 3 M.	-42° 3 M.	25	S	19 6 10	42 21 47	-39° 6 M.	-39° 6 M.	25	M
26	Tu	16 110 6	4 13 S	-61° 1 M.	-61° 1 M.	26	Th	16 22 9	36 5 43	-54° 5 M.	-54° 5 M.	26	F	20 10 11	35 23 50	-84° 0 M.	-84° 0 M.	26	Tu
27	W	17 210 55	1 43 N	-73° 3 M.	-73° 3 M.	27	Th	17 39 10	23 11 2	-66° 7 M.	-66° 7 M.	27	S	22 10 11	24 24 43	+84° 0 E.	+84° 0 E.	27	W
28	Th	18 411 43	7 28	-85° 5 M.	-85° 5 M.	28	F	18 56 11	11 15 45	-78° 9 M.	-78° 9 M.	28	Tu	4 42 13	18 24 25	+71° 8 E.	+71° 8 E.	28	Th
29	F	19 59 12	31 12 44 N	-82° 4 E.	-82° 4 E.	29	S	19 59 12	31 12 44 N	+89° 0 E.	+89° 0 E.	29	W	5 40 14	7 22 0 N	+59° 6 E.	+59° 6 E.	29	F

Radiant-points of the principal Meteoric Showers of the Year.

By W. F. DENNING.

Date.	Radiant.		Meteors.	Date.	Radiant.		Meteors.
	α	δ			α	δ	
Jan. 2 ...	230	+53	Swift; long paths.	July 28 ...	339	-12	Slow; long.
3 ...	156	+41	Swift.	30 ...	6	+35	Swift; streaks.
11 ...	220	+13	Swift; streaks.	Aug. 4 ...	30	+36	Swift; streaks.
17 ...	295	+53	Slow; bright.	4-10	350	+51	Swift.
22 ...	208	-8	Very swift; streaks.	10 ...	45	+57	Swift; streaks.
25 ...	131	+32	Swift.	14 ...	311	+62	Rather swift.
29 ...	213	+52	Very swift.	15 ...	292	+53	Swift; bright.
Feb. 5-10	74	+43	Slow; bright.	16 ...	61	+48	Swift; streaks.
15 ...	236	+11	Swift; streaks.	22 ...	291	+60	Slow; bright.
15 ...	261	+4	Swift; streaks.	25 ...	5	+11	Slow; short.
20 ...	181	+34	Swift; bright.	Sept. 4 ...	346	$\pm$ 0	Slow.
20 ...	263	+36	Swift; streaks.	7 ...	62	+37	Swift; streaks.
Mar. 4 ...	175	+10	Slow; bright.	10 ...	73	+41	Swift; streaks.
14 ...	250	+54	Swift.	15 ...	48	+44	Very swift.
18 ...	316	+76	Slow; bright.	15 ...	77	+57	Swift; streaks.
24 ...	161	+58	Swift.	21 ...	31	+19	Slow.
27 ...	229	+32	Swift; small.	22 ...	335	+58	Slowish.
28 ...	263	+62	Rather swift.	27 ...	75	+15	Swift; streaks.
Apr. 12-24	210	-10	Slow fireballs.	Oct. 2 ...	225	+52	Slow; bright.
18 ...	231	+17	Swift; short.	4 ...	133	+79	Swift; streaks.
19 ...	218	+33	Slow; bright.	4 ...	310	+77	Slowish.
19 ...	229	-2	Slow; long.	8 ...	77	+31	Swift; streaks.
20 ...	270	+33	Swift.	11-15	29	+72	Small; short.
25 ...	272	+21	Swift; short.	14 ...	40	+20	Rather swift.
30 ...	291	+59	Rather slow.	18 ...	92	+15	Swift; streaks.
May 1 ...	239	+46	Small; short.	20 ...	106	+12	Swift; streaks.
5 ...	254	-21	Slowish.	29 ...	109	+23	Very swift.
6 ...	338	-2	Swift; streaks.	Nov. 1 ...	43	+22	Slow; bright.
7 ...	244	+7	Slow; bright.	2 ...	55	+9	Slow; bright.
11 ...	231	+27	Slow; small.	7 ...	102	+73	Very swift.
29 ...	264	+64	Slowish.	10-12	133	+31	Very swift; streaks.
30 ...	333	+27	Swift; streaks.	13-15	150	+22	Swift; streaks.
June 7 ...	249	-20	Slow; fireballs.	16 ...	154	+41	Swift; streaks.
10 ...	261	+5	Very slow.	20 ...	62	+23	Slow; bright.
13 ...	310	+61	Swift; streaks.	23-27	25	+44	Very slow; trains
15 ...	291	+52	Swift; small.	30 ...	190	+58	Swift; streaks.
15 ...	285	+23	Slowish.	Dec. 4 ...	162	+58	Swift; streaks.
20 ...	335	+57	Swift.	4-7	143	+49	Swift; streaks.
26 ...	354	+39	Swift; streaks.	6 ...	80	+23	Slow; bright.
July 4 ...	303	+24	Swift.	8 ...	145	+7	Swift; streaks.
7 ...	333	+26	Swift.	8 ...	208	+71	Rather swift.
6-12	282	-13	Very slow.	10 ...	108	+33	Swift; short.
19 ...	314	+48	Swift; short.	12 ...	119	+29	Rather swift.
22 ...	16	+31	Swift; streaks.	22 ...	194	+67	Swift; streaks.
25 ...	48	+43	Swift; streaks.	25 ...	98	+31	Very slow.

The radiant-points of the more brilliant showers are indicated by heavier type. The Leonids and Andromedes of November will probably furnish brilliant displays in 1898.

The Perseids, with max. on August 10, are visible for a considerable period and their radiant point exhibits an easterly motion amongst the stars. The following is an ephemeris:—

Date.	Radiant.		Date.	Radiant.		Date.	Radiant.	
	α	δ		α	δ		α	δ
July 19 ...	19	+51	July 29 ...	32	+54	Aug. 8 ...	42	+57
21 ...	22	+52	31 ...	34	+55	10 ...	45	+57
23 ...	25	+52	Aug. 2 ...	36	+55	12 ...	47	+57
25 ...	27	+53	4 ...	38	+56	14 ...	50	+58
27 ...	30	+54	6 ...	40	+56	16 ...	53	+58

Jupiter (♃).

Saturn (♄).

1898.	R.A. Noon.	Dec. Noon.	Diam.	Rises.	Trans- its.	Sets.	R.A. Noon.	Dec. Noon.	Diam.	Rises.	Trans- its.	Sets.
	h m s	° ' S.	"	h m	h m	h m	h m s	° ' S.	"	h m	h m	h m
Jan. 1	12 36 50	2 32 S.	34.2	11 59	17 50	23 41	16 24 18	19 53 S.	14.2	17 20	21 36	1 52
21	12 39 59	2 47	36.4	10 45	16 34	12 23	16 32 28	20 10	14.6	16 12	20 26	0 40
Feb. 10	12 38 29	2 31	38.4	9 24	15 14	21 4	16 38 51	20 21	15.0	15 1	19 14	23 27
Mar. 2	12 32 41	1 50	40.0	7 54	13 49	19 43	16 42 54	20 26	15.4	13 47	17 59	22 11
22	12 23 59	0 51 S.	40.8	6 24	12 22	18 20	16 44 13	20 26	16.0	12 30	16 41	0 52
Apr. 11	12 14 44	0 8 N.	40.6	4 51	10 54	16 57	16 42 44	20 21	16.4	11 8	15 21	19 34
May 1	12 7 25	0 52	39.2	3 21	9 28	15 35	16 38 48	20 12	17.0	9 45	13 59	18 13
21	12 3 48	1 11	37.4	1 57	8 6	14 15	16 33 10	20 0	17.0	8 20	12 35	16 50
June 10	12 4 32	1 1	35.2	0 40	6 48	12 56	16 26 58	19 48	17.0	6 54	11 10	15 26
30	12 9 25	0 24 N.	33.2	23 29	5 34	11 39	16 21 27	19 38	16.8	5 29	9 46	14 3
July 20	12 17 52	0 36 S.	31.4	22 24	4 24	10 24	16 17 39	19 33	16.4	4 5	8 23	12 41
Aug. 9	12 29 10	1 52	30.2	21 23	3 17	9 11	16 16 16	19 34	16.0	2 45	7 3	11 21
29	12 42 37	3 21	29.2	20 26	2 12	7 58	16 17 32	19 42	15.4	1 29	5 46	10 3
Sept. 18	12 57 34	4 58	28.6	19 30	1 8	6 46	16 21 25	19 56	15.0	0 16	4 31	8 46
Oct. 8	13 13 27	6 36	28.2	18 36	0 5	5 34	16 27 35	20 13	14.6	23 8	3 19	7 30
28	13 29 40	8 14	28.4	17 38	22 59	4 20	16 35 35	20 34	14.2	21 57	2 8	6 19
Nov. 17	13 45 36	9 45	28.8	16 42	21 56	3 10	16 44 52	20 54	14.0	20 50	0 58	5 8
Dec. 7	14 0 32	11 5	29.8	15 47	20 53	1 59	16 54 49	21 12	14.0	19 37	23 46	3 53
27	14 13 40	12 12 S.	31.0	14 47	19 47	0 47	17 4 48	21 27 S.	14.0	18 33	22 38	2 43

Uranus (♅).

Neptune (♆).

Jan. 1	15 58 36	20 21 S.	3.4	16 58	21 11	1 24	5 19 30	21 44 N.	2.7	2 29	10 33	18 37
31	16 3 52	20 36	3.5	15 7	19 18	23 29	5 16 45	21 42	2.7	0 28	8 32	16 36
Mar. 2	16 6 13	20 42	3.6	13 12	17 22	21 32	5 15 48	21 43	2.6	22 29	6 33	14 37
Apr. 1	16 5 13	20 39	3.7	11 13	15 23	19 33	5 17 0	21 45	2.6	20 32	4 37	12 40
May 1	16 1 27	20 29	3.8	9 11	13 21	17 32	5 20 7	21 50	2.6	18 37	2 42	10 47
31	15 56 21	20 15	3.8	7 4	11 18	15 32	5 24 30	21 55	2.5	16 43	0 48	8 53
June 30	15 51 40	20 1	3.8	5 1	9 16	13 31	5 29 17	21 59	2.5	14 45	22 51	6 57
July 30	15 49 28	19 55	3.8	3 59	7 16	11 32	5 33 34	22 1	2.5	12 52	20 58	5 4
Aug. 29	15 50 10	19 57	3.7	1 3	5 18	9 33	5 36 31	22 2	2.6	10 57	19 3	3 9
Sept. 28	15 53 57	20 9	3.6	23 10	3 24	7 38	5 37 32	22 2	2.6	9 0	17 6	1 12
Oct. 28	16 0 9	20 28	3.5	21 21	1 32	5 43	5 36 26	22 0	2.6	7 0	15 6	23 12
Nov. 27	16 7 42	20 49	3.4	19 29	23 38	3 47	5 33 34	21 58	2.7	5 0	13 6	21 12
Dec. 27	16 15 14	21 9 S.	3.4	17 45	21 48	1 51	5 29 59	21 55 N.	2.7	2 59	11 4	19 9

Ceres.

Pallas.

1898.	R.A. Noon.	Dec. Noon.	Transits.	1898.	R.A. Noon.	Dec. Noon.	Transits.
	h m	° ' N.	h m		h m	° ' S.	h m
Jan. 5 ...	6 12	28 18 N.	11 9	Jan. 5 ...	2 12	23 47 S.	7 11
29 ...	5 54	29 23	9 17	29 ...	2 31	19 38	5 55
Feb. 22 ...	5 52	29 53	7 41	Dec. 7 ...	12 33	7 33	19 26
Mar. 18 ...	6 8	30 4 N.	6 23	31 ...	13 9	7 0 S.	18 27

Juno.

Vesta.

Feb. 2 ...	13 54	4 48 S.	15 41	Mar. 18 ...	15 29	8 22 S.	15 43
Mar. 18 ...	13 46	2 8 S.	13 59	Apr. 11 ...	15 27	7 9	14 5
Apr. 11 ...	13 28	1 3 N.	12 7	May 5 ...	15 8	5 53	12 12
May 5 ...	13 11	3 26 N.	10 15	29 ...	14 47	5 49	10 16
29 ...	13 2	4 16 N.	8 32	June 22 ...	14 38	7 27 S.	8 34

The times of rising and setting correspond to the adjacent transit, irrespective of the day given in the first column.

ECLIPSES IN 1898.

In the year 1898 there will be three Eclipses of the Sun and three of the Moon.

I.—*A Partial Eclipse of the Moon, 1898, January 7.*

Visible at Greenwich. Magnitude of the Eclipse (Moon's diam.=1), 0.157. The first contact with the shadow occurs at 169° from the North point towards the East. Last contact 143° towards the West.

	h	m		h	m
First contact with Penumbra	10	1.2	With shadow	11	47.4
Last " " "	15	8.6	" " "	13	22.4

II.—*A Total Eclipse of the Sun, 1898, January 21.*

The circumstances of this Eclipse are given in the Companion for 1897.

III.—*A Partial Eclipse of the Moon, 1898, July 3.*

Partly visible at Greenwich. Magnitude of the Eclipse (Moon's diam.=1), 0.934. The first contact with the shadow occurs at 49° from the North point towards the East. Last contact at 70° towards the West.

	h	m		h	m
First contact with Penumbra	6	48.0	With shadow	7	46.0
Last " " "	11	47.0	" " "	10	49.0

The Moon will rise at Greenwich at 8^h 18^m.

IV.—*An Annular Eclipse of the Sun, 1898, July 18.*

Invisible at Greenwich. The line of Central Eclipse lies wholly in the South Pacific, and this phenomenon is therefore of little interest.

V.—*A Partial Eclipse of the Sun, 1898, Dec. 12–13.*

Invisible at Greenwich. Greatest Eclipse Dec. 12^d 23^h 58^m.2. Magnitude (Sun's diam.=1), 0.025. This Eclipse will be visible only in the South Pacific.

VI.—*A Total Eclipse of the Moon, 1898, Dec. 27.*

Visible at Greenwich.

Greenwich M.T. of δ in R.A.: Dec. 27^d 11^h 37^m 53^s.2.

ζ 's R.A. 6^h 27^m 29^s.50. Hourly motion 128^s.63. $\odot$'s 11^h.08.

ζ 's Declination	23	30	53.0 N.	Hourly motion	4	9.4
$\odot$'s Declination	23	18	7.4 S.	Hourly motion	0	7.3
ζ 's Equat. Hor. Parallax	54	6.4		True Semidiameter...	14	44.8
$\odot$'s Equat. Hor. Parallax	8.9			True Semidiameter...	16	15.9

	h	m		h	m
First contact with Penumbra	8	34.9	With shadow	9	47.8
Beginning of Total Phase	10	57.4	End	12	26.8
Second contact with Penumbra	14	49.3	With shadow	13	36.4

Magnitude of the Eclipse (Moon's diameter=1), 1.383. The first contact with the shadow occurs at 112° from the North point of the Moon's limb towards the East. Last contact at 95° towards the West.

The Moon will be seen in the shadow in longitudes from about 7^h E. to 6^h W.

OCCULTATIONS, 1898. (VISIBLE AT GREENWICH.)

a.	Star.	Mag.	Disap.		Reap.		Date.	Star.	Mag.	Disap.		Reap.	
			M. T.	P.	M. T.	P.				M. T.	P.	M. T.	P.
l.			h m		h m		June			h m		h m	
	17 Tauri	3.8	7 13	48	8 27	278	4	A Ophiuchi ...	4.7	8 10†	111	9 11	
	23 Tauri	4.2	8 2	110	9 11	220	4	B.A.C. 5909 ...	6.2	15 43	46	16 34†	
	η Tauri	3.0	8 46	89	10 8	245	5	λ Sagittarii ...	3.1	10 15	77	11 22	
	28 Tauri	6.2	9 55	102	11 11	238	9	B.A.C. 7804 ...	6.1	11 31†	96	12 23	
	27 Tauri	3.8	10 1	125	10 59	215							
	125 Tauri	4.9	12 56.	66	13 58	312	July						
	B.A.C. 2058 ...	6.5	7 47	68	8 57	296	29	B.A.C. 5909 ...	6.2	12 23†	53	13 17†	
	o' Cancri	5.2	8 11	140	9 5	256	30	λ Sagittarii ...	3.1	7 31	77	8 41	
	o² Cancri	5.6	8 11	75	9 5	320							
	B.A.C. 3398 ...	6.0	15 53	136	17 4	290	Aug.						
	B.A.C. 5314 ...	5.4	16 30*	85	17 31	308	8	μ Arietis	5.9	10 7	26	10 44	
	B.A.C. 5347 ...	5.8	18 51	120	20 1	266	11	118 Tauri	5.4	14 49	43	15 38	
							12	8 Geminorum ...	6.5	12 31	114	13 19	
							28	σ Capricorni ...	5.6	12 53	99	13 43	
j.	δ Geminorum ...	3.7	18 43†	161	19 10†	228	Sept.						
	2 ^h Leonis	5.5	12 54	106	14 5	326	5	66 Arietis	6.1	16 44	30	17 41	
	D.M. - 15° 37' 15	6.5	11 0†	95	11 55	321	8	D.M. + 24° 10' 33	6.0	10 52	109	11 42	
	89 Virginis	5.2	17 26	184	17 54	229	9	Mars	...	1 31	135	2 19	
	δ Scorpil	4.8	19 33	128	20 37	250	10	79 Geminorum ...	6.5	14 5	33	14 30	
f.							28	16 Piscium	5.6	13 39	49	14 44	
	B.A.C. 2238 ...	6.5	13 40	94	14 36	298	Oct.						
	d' Cancri	5.9	7 10	115	8 29	287	2	47 Arietis	5.9	10 27	61	11 35	
	B.A.C. 4201 ...	6.3	7 51*	89	8 42	329	4	B.A.C. 1518 ...	6.5	16 40	111	17 57	
	q Virginis	5.7	11 12	67	11 51	1	5	132 Tauri	5.1	16 6	78	17 27	
	D.M. - 13° 36' 92	6.5	9 7*	53	9 32	4	19	B.A.C. 5878 ...	6.5	4 50	86	6 1	
	α Scorpil	1.1	14 38	90	15 49	294	22	π Capricorni ...	5.2	3 44	73	4 57	
	B.A.C. 5513 ...	6.5	15 38	93	16 52	286	22	ρ Capricorni ...	5.0	5 5	16	5 51	
	δ Geminorum ...	3.7	11 13	120	12 14	279	23	18 Aquarii ...	5.4	5 13	28	6 13	
	63 Geminorum ...	5.3	14 44	106	15 34†	285	29	μ Arietis	5.8	13 21	21	14 10	
							Nov.						
							1	103 Tauri	5.5	5 17†	56	6 0†	
f.	A Ophiuchi ...	4.7	14 38	27	15 8	340	19	D.M. - 13° 58' 91	6.5	8 23	48	9 25	
	62 Tauri	6.2	9 46	127	10 27*	233	20	B.A.C. 7717 ...	6.5	9 0	33	9 59	
	79 Geminorum ...	6.5	6 41	150	7 44	256	21	D.M. - 3° 55' 39	6.3	7 35	95	8 32	
	ξ Leonis	5.2	13 1	40	13 15	10	22	19 Piscium	5.2	7 9	25	8 13	
							28	103 Tauri	5.5	14 7	136	15 6	
y							29	D.M. + 24° 10' 33	6.0	11 19	23	11 49	
	B.A.C. 4006 ...	5.7	11 24	169	12 11	253	Dec.						
	B.A.C. 7263 ...	6.0	13 16	13	13 51	308	2	B.A.C. 2888 ...	6.5	17 27	162	18 22	
	B.A.C. 7620 ...	6.5	15 22	350	15 41	317	5	55 Leonis	6.0	20 2	142	21 11	
	Venus	...	6 54	158	7 32	226	6	e Leonis	5.1	12 54	177	13 24	
	d² Cancri	6.2	10 25	98	11 18	305	19	κ Piscium	5.0	3 0	11	3 46	
	36 Sextantis ...	6.5	11 0	127	12 0	288	23	47 Arietis ...	5.9	9 4	108	10 11	
	e Leonis	5.1	10 17	147	11 16	271	29	ζ Cancri	5.0	10 1	92	11 16	

* Star rising.

† Star setting.

† Star below horizon.

The angles (P) are reckoned from the true N. point in the direction N., E., S., W., i. e. from the bottom of the Moon's inverted image towards the right.

The following "near approaches" are also given in the 'Nautical Almanac,' and are especially interesting to observers rather South and rather North of Greenwich respectively:—

North Near Approaches.

Date.	Star.	Mag.	G.M.T.	Angle.	Date.	Star.	Mag.	G.M.T.	Angle.
Jan.			h m	°	May			h m	°
3	16 Tauri	6.5	7 55	342	27	π Leonis	5.0	11 37	25
8	δ^1 Cancri	5.9	17 53	25	June				
Feb.					3	B.A.C. 5403 ...	6.4	11 56	8
5	α^1 Cancri	5.2	17 34	25	3	σ Scorpii	3.0	14 52	1
7	43 Leonis	6.5	10 50	32	July				
Mar.					7	D.M.—3°5539 ..	6.3	13 54	328
26	23 Tauri	4.2	9 24	357	28	B.A.C. 5403 ...	6.4	7 6	11
Apr.					28	σ Scorpii	3.0	10 19	3
1	α^1 Cancri	5.2	10 11	30	Nov.				
26	44 Geminorum.	5.9	12 17	15	28	B.A.C. 1518 ...	6.5	7 41	350°
May					Dec.				
4	D.M.—15°3715 ..	6.5	13 14	23	18	π Aquarii	5.5	4 31	327
27	B.A.C. 3407 ...	6.4	10 27	28	25	B.A.C. 1518 ...	6.5	16 13	5

South Near Approaches.

Date.	Star.	Mag.	G.M.T.	Angle.	Date.	Star.	Mag.	G.M.T.	Angle.
Jan.			h m	°	Oct.			h m	°
10	B.A.C. 3407 ...	6.4	17 53	212	8	ζ Cancri	5.0	12 0	191
Feb.					24	θ Aquarii	4.3	5 27	151
11	87 Virginis ...	5.7	16 11	209	Nov.				
Mar.					28	99 Tauri.....	6.0	8 22	171
28	118 Tauri	5.4	8 6	188	29	3 Geminorum ..	6.5	19 14	192
Apr.					Dec.				
9	B.A.C. 5314 ...	5.4	11 33	197	19	16 Piscium.....	5.6	9 7	152
Oct.					25	99 Tauri	6.0	17 1	185
5	121 Tauri	5.4	9 29	175	26	121 Tauri	5.4	8 2	176
					28	61 Geminorum.	5.7	13 24	199

Approximate Times and Position-angles of Stars which will be occulted (as seen from Greenwich) during the Total Lunar Eclipse of 1898, Dec. 27.

Star.	Mag.	Disapp.			Reapp.		
		M.T.	P.	V.	M.T.	P.	V.
		h m	°	°	h m	°	°
B.D. +23°1389.....	9.0	10 12	84	115	11 32	292	301
+23°1391.....	8.8	10 14	91	121	11 36	286	294
+22°1374.....	9.5	10 38	152	176	11 28	226	237
+23°1392.....	9.4	10 42	35	58	11 16	344	358
+22°1375.....	9.5	10 44	159	181	11 26	219	230
+23°1398.....	8.6	10 45	62	84	11 53	320	323
+23°1402.....	9.4	10 53	89	109	12 14	290	287
+23°1403.....	8.7	11 3	90	107	12 25	291	285
+22°1385.....	9.5	11 38	163	170	12 16	224	220
+23°1409.....	9.5	11 41	93	100			
+23°1407.....	8.8	11 43	38	44	12 19	343	338
+22°1392.....	9.0	11 55	122	124			
+23°1412.....	9.5	12 15	30	26	12 39	354	343
+23°1415.....	9.3	12 18	93	88			
+23°1416.....	9.4	12 20	94	89			
+23°1418.....	9.4	12 28	89	82			

Approximate Times and Position-angles of Stars which will be occulted (as seen from Greenwich) during the Partial Lunar Eclipse of 1898, July 3.

Star. Cordoba D.M.	Mag.	Disapp.			Reapp.		
		M. T.	P.	V.	M. T.	P.	V.
—24°14904	8.3	h m	°	°	h m	°	°
—24°14908	9.0	8 42	117	146	9 36	228	251
—24°14928	8.6	8 53	119	147	9 47	225	246
		9 26	73	97	10 32	266	281

TABLE OF BESSEL'S MEAN REFRACTIONS.

Z. D.	Mean Refraction.	Z. D.	Mean Refraction.	Z. D.	Mean Refraction.	Z. D.	Mean Refraction.
0	0° 0'	56	1° 25.4	68	2° 21.9	78	4° 25.0
10	10.2	58	1° 32.1	69	2° 29.3	79	4° 48.5
20	21.0	60	1° 39.7	70	2° 37.3	80	5° 16.2
30	33.3	61	1° 43.8	71	2° 46.1	81	5° 49.3
35	40.4	62	1° 48.2	72	2° 55.8	82	6° 29.6
40	48.4	63	1° 52.8	73	3° 6.6	83	7° 19.7
45	57.7	64	1° 57.8	74	3° 18.6	84	8° 23.3
50	1° 8.7	65	2° 3.2	75	3° 32.1	85	9° 46.5
52	1° 13.8	66	2° 8.9	76	3° 47.4		
54	1° 19.3	67	2° 15.2	77	4° 4.9		

CONFIGURATIONS OF JUPITER'S SATELLITES
FOR AN INVERTING TELESCOPE.

Day.	Jan. 16 ^h	Feb. 14 ^h	March. 13 ^h	April. 11 ^h	May. 10 ^h	June. 10 ^h	July. 9 ^h	Aug. 8 ^h	Sept. 7 ^h	Nov. 18 ^h	Dec. 18 ^h	Day.
1	20413	10324	04123	43210	43102	40123	20134	31024	20431		32104	1
2	41203	32014	21302	21302	42013	41023	23104	32014	10243		21304	2
3	40132	31204	32104	21301	42033	42130	30124	21024	20134		40132	3
4	214310	34012	30214	21043	41023	43201	34023	210234	20344		214103	4
5	43201	41023	31024	02134	42031	43102	42130	01243	31024		42013	5
6	43023	42013	20134	10234	23140	43201	42013	21043	30124		41032	6
7	41023	40123	12034	23014	30214	42103	41023	34201	32104		41012	7
8	42013	41032	01243	32104	31024	40123	42013	34102	20144		43210	8
9	41203	43201	02344	30124	20144	10423	42130	214301	10423		43201	9
10	04123	43210	32410	30244	21034	213034	43012	42130	214013		40323	10
11	13024	34012	43012	21043	10234	32044	34023	40123	42103		10243	11
12	32014	14023	43102	40213	21034	31024	23410	40213	214302	01234	20134	12
13	31024	20143	42013	41023	23104	21304	20143	42103	43012	12034	10234	13
14	213024	03444	42103	42031	30214	21034	10234	42301	43210	20134	30124	14
15	20134	10234	40123	43210	31402	02134	21034	31042		31042	32104	15
16	21034	23014	41032	43012	20143	10243	21034	30214		34012	32014	16
17	01243	32104	21304	43023	42103	21034	30214	21304		43201	02444	17
18	13042	30124	30214	42103	214023	34201	31024	02134		41304	10243	18
19	34201	13024	31024	40133	40123	43102	21304	02344		40132	24013	19
20	43102	20143	20314	10423	42031	43021	20134	21034		41203	41033	20
21	43012	41033	21034	21014	43013	42103	14023	23014		42013	41012	21
22	42013	214032	01234	34102	40133	40213	31024	31024		41302	43120	22
23	42103	43201	10234	30124	23401	41023	42103	30421		34012	43201	23
24	40123	43210	23014	31024	21043	42013	43013	24301		32044	41023	24
25	41032	43012	30444	21034	01234	32410	43102	40133		31044	214023	25
26	32013	41302	31402	01344	02344	213042	43201	41023		01324	42013	26
27	31044	42013	42031	10243	23104	30124	42033	214023		12034	14033	27
28	30124	41203		24031	30144	21044	41023	42031		20134	30142	28
29	20344		40123	34210	30124	01344	40213	43102		10324	31204	29
30	21034		41023	43012	32014	10234	21034	43021		30124	32014	30
31	01234		42013	21043			30144	23410			31024	31

The circle (O) represents Jupiter; 21 signifies that the satellite is on the disk;
● signifies that the satellite is behind the disk or in the shadow.

SATELLITES OF MARS
DURING THE OPPOSITION OF 1898-9.

East Elongations.

PHOBOS.

November.	Nov. (con.).	Nov. (con.).	Dec. (con.).	Dec. (con.).	Dec. (con.).
d h	d h	d h	d h	d h	d h
14 3'5	22 3'0	30 2'3	7 10'3	15 17'3	24 0'3
11'2	10'6	9'9	18'0	16 1'0	7'9
18'8	18'3	17'6	8 1'7	8'7	15'5
15 2'5	23 1'9	December.	9'3	16'3	23'2
11'1	9'5		16'9	23'9	25 6'9
18'8	17'2		9 0'6	17 7'5	14'5
16 2'4	24 0'8		8'3	15'2	22'2
9'1	8'5	1 1'3	15'9	22'9	26 5'8
16'8	16'2	16'6	23'5	18 6'5	13'5
17 0'2	23'8	2 0'2	10 7'2	14'2	21'1
7'9	25 7'5	7'8	14'9	21'8	27 4'8
15'6	15'2	15'5	22'5	19 5'5	12'4
23'3	22'8	23'1	11 6'1	13'2	20'0
18 7'0	26 6'5	3 6'8	13'8	20'8	28 3'7
14'7	14'1	14'4	21'4	20 4'4	11'4
22'4	21'8	22'1	12 5'7	12'0	19'1
19 6'0	27 5'4	4 5'8	12'7	19'7	29 2'7
13'7	13'0	13'4	20'4	21 3'3	10'3
21'3	20'7	21'1	13 4'1	11'0	17'9
20 4'9	28 4'3	5 4'7	11'8	18'7	30 1'6
12'6	12'0	12'4	19'4	22 2'4	9'2
20'3	19'6	20'0	14 3'1	10'0	16'9
21 3'9	29 3'2	6 3'7	10'8	17'7	31 0'6
11'6	10'9	11'4	18'5	23 1'3	8'3
19'3	18'6	19'0	15 2'1	9'0	15'9
		7 2'7	9'7	16'6	23'6

DEIMOS.

November.	Nov. (con.).	Nov. (con.).	December.	Dec. (con.).	Dec. (con.).
d h	d h	d h	d h	d h	d h
7 21'3	18 0'0	28 2'5	1 21'4	11 23'8	22 2'2
9 3'6	19 6'3	29 8'8	3 3'7	13 6'1	23 8'4
10 9'9	20 12'6	30 15'1	4 10'0	14 12'4	24 14'7
11 16'3	21 18'9		5 16'3	15 18'7	26 21'0
12 22'6	23 1'2		6 22'6	17 1'0	27 3'3
14 5'0	24 7'5		8 4'9	18 7'3	28 9'6
15 11'3	25 13'9		9 11'2	19 13'6	29 15'8
16 17'6	26 20'2		10 17'5	20 19'7	30 22'1

Apparent Disk of Mars, 1898.

Jan. 1 0'995	May 31 0'928	Sept. 28 0'878
31 0'986	June 30 0'912	Oct. 28 0'888
Mar. 2 0'974	July 30 0'896	Nov. 27 0'917
April 1 0'960	Aug. 29 0'883	Dec. 27 0'979
May 1 0'944		

The numbers in this table are the versed sines of the illuminated disk, the apparent diameter of the planet being taken as unity.

JUPITER'S SATELLITES, 1898.

Phenomena.

e, Signifies Ec. dis.; E, Ec. re.; o, Occ. dis.; O, Occ. re.; t, Tr. Ing.; T, Tr. Egr.

January.			Jan. (con.).			Jan. (con.).			Feb. (con.).			Feb. (con.).			Mar. (con.).		
d	h	m	d	h	m	d	h	m	d	h	m	d	h	m	d	h	m
1	2	32 ii. t.	13	16	3 i. e.	26	1	43 ii. T.	7	7	13 ii. e.	19	17	11 iii. o.	4	4	21 ii. e.
5	4	ii. T.	19	27	i. O.	4	39	i. O.	10	38	i. e.	19	28	ii. t.	5	14	i. e.
6	45	i. e.	14	14	22 i. t.	14	55	iv. e.	11	40	ii. O.	19	35	iii. O.	7	50	ii. O.
10	12	i. O.	16	36	i. T.	16	26	iv. E.	13	48	i. O.	19	56	i. e.	7	56	i. O.
2	5	6 i. t.	18	12	iii. e.	23	34	i. t.	8	8	44 i. t.	21	55	ii. T.	5	2	55 i. t.
7	21	i. T.	20	59	iii. E.	27	1	49 i. T.	10	58	i. T.	22	53	i. O.	5	9	i. T.
18	16	ii. e.	23	7	iii. o.	15	20	ii. e.	23	51	iii. t.	20	17	51 i. t.	21	56	iii. e.
23	18	ii. O.	15	1	40 iii. O.	19	49	i. e.	9	2	16 iii. T.	20	5	i. T.	23	43	i. e.
3	1	13 i. e.	7	34	ii. t.	20	3	ii. O.	3	59	ii. t.	21	12	25 ii. e.	23	58	ii. t.
4	40	i. O.	10	4	ii. T.	23	6	i. O.	5	6	i. e.	14	24	i. e.	6	2	20 iii. C.
23	34	i. t.	10	31	i. e.	28	18	2 i. t.	6	27	ii. T.	16	22	ii. O.	2	22	i. O.
4	1	49 i. T.	13	55	i. O.	20	16	i. T.	8	14	i. O.	17	19	i. O.	2	26	ii. T.
5	1	13 i. t.	16	8	49 i. t.	29	2	8 iii. e.	10	3	11 i. t.	22	12	17 i. t.	21	21	i. t.
7	48	iii. T.	11	4	i. T.	4	53	iii. E.	5	25	i. T.	14	31	i. T.	23	35	i. T.
15	48	ii. t.	23	26	ii. e.	6	35	iii. o.	20	32	ii. e.	23	6	48 iii. t.	7	17	38 ii. e.
18	20	ii. T.	17	4	21 ii. O.	9	3	iii. O.	23	35	i. e.	8	36	ii. t.	18	11	i. e.
19	41	i. e.	4	59	i. e.	12	27	ii. t.	11	0	51 ii. O.	8	53	i. e.	20	48	i. O.
23	8	i. O.	8	22	i. O.	14	17	i. e.	2	41	i. O.	9	11	iii. T.	20	59	ii. O.
5	18	2 i. t.	18	3	17 i. t.	14	55	ii. T.	21	38	i. t.	11	3	ii. T.	8	15	47 i. t.
20	7	i. T.	5	32	i. T.	17	33	i. O.	23	52	i. T.	11	46	i. O.	18	1	i. T.
6	7	34 ii. e.	12	53	iii. t.	30	12	29 i. t.	12	9	1 iv. e.	24	6	43 i. t.	9	12	39 i. e.
12	35	ii. O.	15	25	iii. T.	14	43	i. T.	10	3	iii. e.	8	57	i. T.	13	5	ii. t.
14	10	i. e.	20	48	ii. t.	31	4	38 ii. e.	10	10	iv. E.	25	1	44 ii. e.	13	29	iii. t.
17	36	i. O.	23	18	ii. T.	8	45	i. e.	12	46	iii. E.	3	21	i. e.	15	14	i. O.
7	12	30 i. t.	23	27	i. e.	9	16	ii. O.	13	44	iii. o.	5	32	ii. O.	15	33	ii. T.
14	14	iii. e.	19	2	50 i. O.	12	0	i. O.	16	8	iii. O.	6	12	i. O.	15	53	iii. T.
14	45	i. T.	21	45	i. t.	February.			17	10	ii. t.	26	1	10 i. t.	10	10	13 i. t.
17	3	iii. E.	23	59	i. T.	1	6	56 i. t.	18	3	i. e.	3	24	i. T.	12	27	i. T.
19	16	iii. o.	20	12	45 ii. e.	1	9	10 i. T.	19	37	ii. T.	17	58	iii. e.	11	6	57 ii. e.
21	53	iii. O.	17	35	ii. O.	20	16	iii. t.	21	8	i. O.	21	44	ii. t.	7	8	i. e.
8	5	4 ii. t.	17	56	i. e.	22	43	iii. T.	13	16	4 i. t.	21	49	i. e.	9	40	i. O.
7	35	ii. T.	21	17	i. O.	4	7	ii. T.	18	18	i. T.	22	58	iii. o.	10	7	ii. O.
8	38	i. e.	21	16	12 i. t.	2	1	38 ii. t.	14	9	49 ii. e.	27	0	11 ii. T.	12	4	39 i. t.
12	4	i. O.	18	27	i. T.	3	13	i. e.	12	31	i. e.	0	38	i. O.	6	53	i. T.
9	6	58 i. t.	22	10	iii. e.	4	7	ii. T.	14	2	ii. O.	19	36	i. t.	13	1	36 i. e.
9	13	i. T.	22	0	56 iii. E.	6	27	i. O.	15	34	i. O.	21	50	i. T.	1	55	iii. e.
20	51	ii. e.	2	53	iii. o.	3	1	23 i. t.	15	10	31 i. t.	28	15	2 ii. e.	2	12	ii. t.
20	51	iv. e.	5	24	iii. O.	3	37	i. T.	12	45	i. T.	16	17	i. e.	4	6	i. O.
22	40	iv. E.	10	1	ii. t.	17	56	ii. e.	16	3	21 iii. t.	18	41	ii. O.	4	40	ii. T.
10	1	51 ii. O.	12	24	i. e.	21	42	i. e.	5	45	iii. T.	19	4	i. O.	5	38	iii. C.
3	6	i. e.	12	31	ii. T.	22	28	ii. O.	6	19	ii. t.	March.			23	5	i. t.
6	32	i. O.	15	45	i. O.	4	0	54 i. C.	6	59	i. e.	1	3	13 iv. e.	14	1	19 i. T.
11	1	26 i. t.	23	10	40 i. t.	19	50	i. t.	8	46	ii. T.	3	49	iv. E.	20	4	i. e.
3	41	i. T.	12	54	i. T.	22	4	i. T.	10	0	i. O.	14	2	i. t.	20	15	ii. e.
9	4	iii. t.	24	2	2 ii. e.	5	6	6 iii. e.	17	4	58 i. t.	16	16	i. T.	22	32	i. O.
11	39	iii. T.	6	50	ii. O.	8	49	iii. E.	7	12	i. T.	16	16	i. T.	23	15	ii. O.
18	19	ii. t.	6	52	i. e.	10	12	iii. o.	23	8	ii. e.	2	10	10 iii. t.	15	17	31 i. t.
20	50	ii. T.	10	12	i. O.	12	38	iii. O.	18	1	28 i. e.	10	46	i. e.	19	45	i. T.
21	34	i. e.	25	5	7 i. t.	14	49	ii. t.	3	12	ii. O.	10	51	ii. t.	16	14	31 i. e.
12	1	0 i. O.	7	22	i. T.	16	10	i. e.	4	27	i. O.	12	33	iii. T.	15	18	ii. .
19	54	i. t.	16	37	iii. t.	17	17	ii. T.	23	24	i. t.	13	19	ii. T.	16	46	iii. t.
22	9	i. T.	19	6	iii. T.	19	21	i. O.	19	1	38 i. T.	13	30	i. O.	16	58	i. O.
13	10	9 ii. e.	23	14	ii. t.	6	14	17 i. t.	14	0	iii. e.	3	8	28 i. t.	17	46	ii. T.
15	6	ii. O.	26	1	20 i. e.	16	31	i. T.	16	42	iii. E.	10	42	i. T.	19	11	iii. T.

Mar. (con.).	Apr. (con.).	Apr. (con.).	May (con.).	May (con.).	May (con.).
d h m	d h m	d h m	d h m	d h m	d h m
17 11 57 i. t.	1 17 17 ii. E.	18 0 19 iii. E.	2 11 20 i. t.	17 17 35 ii. o.	31 22 31 ii.
18 11 11 i. t.	2 9 52 i. t.	7 47 i. t.	13 35 i. T.	22 14 ii. E.	
18 9 1 i. e.	12 6 i. T.	10 2 i. T.	3 8 29 i. o.	18 9 24 i. t.	
9 34 ii. e.	3 7 2 i. o.	19 4 57 i. o.	11 32 i. E.	11 40 i. T.	
11 24 i. O.	8 49 ii. t.	7 44 i. E.	12 47 ii. o.	19 6 33 i. o.	1 3 27 ii.
12 23 ii. O.	9 27 i. E.	8 7 ii. o.	17 1 ii. E.	9 50 i. E.	13 6 i.
19 6 23 i. t.	11 19 ii. T.	11 47 ii. E.	4 5 47 i. t.	11 46 ii. t.	15 22 i.
8 37 i. T.	12 59 iii. o.	20 2 13 i. t.	8 2 i. T.	14 20 ii. T.	2 10 14 i.
20 3 29 i. e.	16 26 iii. E.	4 28 i. T.	5 2 56 i. o.	23 8 iii. t.	13 39 i.
4 24 ii. t.	4 4 18 i. t.	23 23 i. o.	6 1 i. E.	20 1 56 iii. T.	16 41 ii.
5 50 i. O.	6 32 i. T.	21 2 12 i. E.	7 1 ii. t.	3 52 i. t.	19 16 ii.
5 53 iii. e.	5 1 28 i. o.	2 25 ii. t.	9 34 ii. T.	6 7 i. T.	3 6 34 iii.
6 53 ii. T.	3 34 ii. o.	4 56 ii. T.	16 1 iii. t.	21 1 0 i. o.	7 34 i.
8 56 iii. O.	3 56 i. E.	9 11 iii. t.	18 45 iii. T.	4 18 i. E.	9 25 iii.
21 0 49 i. t.	6 34 ii. E.	11 49 iii. T.	6 0 14 i. t.	6 48 ii. o.	9 50 i.
3 3 i. T.	22 44 i. t.	20 40 i. t.	2 29 i. T.	11 33 ii. E.	4 4 42 i.
21 58 i. e.	6 0 58 i. T.	22 55 i. T.	21 23 i. o.	22 19 i. t.	8 8 i.
22 51 ii. e.	19 54 i. o.	22 17 49 i. o.	7 0 29 i. E.	22 0 35 i. T.	11 47 ii.
21 0 15 i. O.	21 56 ii. t.	20 41 i. E.	1 58 ii. o.	19 28 i. o.	16 45 ii.
1 31 ii. O.	22 24 i. E.	21 17 ii. o.	6 20 ii. E.	22 47 i. E.	5 2 2 i.
19 15 i. t.	7 0 25 ii. T.	23 1 6 ii. E.	18 41 i. t.	23 0 59 ii. t.	4 18 i.
21 29 i. T.	2 33 iii. t.	15 6 i. t.	20 56 i. T.	3 33 ii. T.	23 10 i.
23 16 26 i. e.	5 6 iii. T.	17 21 i. T.	8 15 50 i. o.	10 17 iv. o.	6 2 36 i.
17 30 ii. t.	17 10 i. t.	24 12 16 i. o.	18 58 i. E.	11 7 iv. O.	5 56 ii.
18 41 i. O.	19 24 i. T.	15 9 i. E.	20 11 ii. t.	13 0 iii. o.	8 31 ii.
19 59 ii. T.	8 14 20 i. o.	15 33 ii. t.	22 45 ii. T.	15 49 iii. O.	20 29 iii.
20 1 iii. t.	16 42 ii. o.	18 5 ii. T.	9 5 49 iii. o.	16 47 i. t.	20 30 i.
22 29 iii. T.	16 53 i. E.	22 55 iii. o.	8 34 iii. O.	17 43 iii. e.	22 46 i.
24 13 41 i. t.	19 53 ii. E.	25 1 34 iii. O.	9 45 iii. e.	19 3 i. T.	23 21 iii.
15 56 i. T.	9 11 36 i. t.	1 46 iii. e.	12 13 iii. E.	20 9 iii. E.	7 1 42 iii.
25 10 53 i. o.	13 50 i. T.	4 17 iii. E.	13 8 i. t.	24 13 55 i. o.	4 5 iii.
12 10 ii. o.	10 8 46 i. o.	9 31 i. t.	15 23 i. T.	17 16 i. E.	17 38 i.
13 7 i. O.	11 2 ii. t.	11 48 i. T.	10 10 17 i. o.	20 2 ii. o.	21 5 i.
14 40 ii. E.	11 21 i. E.	6 42 i. o.	13 27 i. E.	25 0 50 ii. E.	8 1 3 ii.
26 8 7 i. t.	13 33 ii. T.	9 38 i. E.	15 10 ii. o.	11 15 i. t.	6 3 ii.
10 22 i. T.	16 15 iii. o.	10 26 ii. o.	19 37 ii. E.	13 30 i. T.	14 58 i.
27 5 19 i. o.	20 22 iii. E.	14 24 ii. E.	11 7 35 i. t.	26 8 23 i. o.	17 14 i.
6 37 ii. t.	11 6 2 i. t.	27 4 0 i. t.	9 50 i. T.	11 44 i. E.	9 2 47 iv.
7 34 i. E.	8 17 i. T.	6 15 i. T.	12 4 44 i. o.	14 12 ii. t.	4 17 iv.
9 5 ii. T.	3 12 i. o.	28 1 9 i. o.	7 55 i. E.	16 47 ii. T.	12 7 i.
9 44 iii. o.	5 50 i. E.	4 6 i. E.	9 23 ii. t.	27 2 49 iii. t.	15 34 i.
12 28 iii. E.	5 50 ii. o.	4 42 ii. t.	11 57 ii. T.	5 39 iii. T.	19 11 ii.
28 2 33 i. t.	9 11 ii. E.	7 14 ii. T.	19 32 iii. t.	5 42 i. t.	21 47 ii.
4 48 i. T.	13 0 28 i. t.	12 34 iii. t.	22 18 iii. T.	7 58 i. T.	10 9 27 i.
23 45 i. o.	2 43 i. T.	15 15 iii. T.	13 2 2 i. t.	28 2 50 i. o.	10 23 iii.
29 1 18 ii. o.	21 38 i. o.	22 26 i. t.	4 18 i. T.	6 13 i. E.	11 43 i.
2 2 i. E.	14 0 9 ii. t.	29 0 41 i. T.	23 11 i. o.	9 17 ii. o.	13 16 iii.
3 58 ii. E.	0 18 i. E.	19 35 i. o.	14 2 24 i. E.	14 9 ii. E.	11 6 35 i.
21 0 i. t.	2 40 ii. T.	22 35 i. E.	4 22 ii. o.	29 0 10 i. t.	10 3 i.
23 14 i. T.	5 51 iii. t.	23 37 ii. o.	8 56 ii. E.	2 26 i. T.	14 19 ii.
30 18 11 i. o.	8 26 iii. T.	30 3 43 ii. E.	20 29 i. t.	21 18 i. o.	16 55 ii.
19 48 ii. t.	18 54 i. t.	16 53 i. t.	22 45 i. T.	30 0 42 i. E.	16 56 ii.
20 30 i. E.	21 9 i. T.	19 8 i. T.	15 17 38 i. o.	3 26 ii. t.	19 22 ii.
22 12 ii. T.	15 16 4 i. o.		20 52 i. E.	6 1 ii. T.	12 3 55 i.
23 17 iii. t.	18 47 i. E.		22 34 ii. t.	16 42 iii. o.	6 11 i.
31 1 47 iii. T.	18 58 ii. o.		16 1 8 ii. T.	18 38 i. t.	13 1 3 i.
15 26 i. t.	22 30 ii. E.		9 22 iii. o.	19 33 iii. O.	4 31 i.
17 40 i. T.	16 13 21 i. t.		12 9 iii. O.	20 54 i. T.	8 28 ii.
	15 35 i. T.		13 44 iii. e.	21 42 iii. e.	11 4 ii.
	17 10 31 i. o.		14 57 i. t.	31 0 7 iii. E.	22 23 i.
	13 15 i. E.		16 11 iii. E.	15 46 i. o.	14 0 21 iii.
	13 17 ii. t.		17 12 i. T.	16 40 iv. t.	0 39 i.
	15 48 ii. T.		17 12 5 i. o.	17 54 iv. T.	3 14 iii.
	19 33 iii. o.		15 21 i. E.	19 10 i. E.	5 41 iv.
		May.			
		1 14 2 i. o.			
		17 4 i. E.			
		17 51 ii. t.			
		20 24 ii. T.			
		2 2 20 iii. o.			
		5 2 iii. O.			
		5 46 iii. e.			
		8 15 iii. E.			
April.					
1 12 36 i. o.					
14 26 ii. o.					
14 59 i. E.					

June (con.).			June (con.).			July (con.).			July (con.).			Aug. (con.).			Aug. (con.).		
d	h	m	d	h	m	d	h	m	d	h	m	d	h	m	d	h	m
14	8	4 iii. E.	27	8	21 i. E.	10	0	48 ii. o.	24	6	11 ii. o.	6	22	5 iii. T.	21	6	43 iii
19	31	i. o.	13	39	ii. t.	5	45	ii. E.	10	56	ii. E.	22	9	i. o.	17	10	ii.
23	0	i. E.	16	15	ii. T.	11	37	i. t.	15	32	i. t.	7	1	22 i. E.	21	15	ii.
15	3	37 ii. o.	28	2	13 i. t.	13	53	i. T.	17	48	i. T.	11	39	ii. o.	23	29	i.
6	13	ii. O.	4	29	i. T.	11	8	45 i. o.	25	12	41 i. o.	16	6	ii. E.	22	1	44 i.
6	14	ii. e.	8	17	iii. o.	12	11	i. E.	16	1	i. E.	19	30	i. t.	20	39	i.
8	39	ii. E.	11	11	iii. O.	28	57	ii. t.	26	0	23 ii. t.	21	45	i. T.	23	40	i.
16	52	i. t.	13	41	iii. e.	21	34	ii. T.	2	59	ii. T.	8	16	39 i. o.	23	11	28 ii.
19	8	i. T.	16	1	iii. E.	12	6	6 i. t.	10	2	i. t.	19	50	i. E.	14	3	ii.
16	14	0 i. o.	23	21	i. o.	8	22	i. T.	12	18	i. T.	9	5	54 ii. t.	14	23	iv.
17	29	i. E.	29	2	50 i. E.	14	52	iv. o.	27	0	52 iii. o.	8	29	ii. T.	15	22	iv.
21	45	ii. t.	8	49	ii. o.	16	28	iii. o.	3	44	iii. O.	13	59	i. t.	17	59	i.
17	0	21 ii. T.	11	26	ii. O.	16	41	iv. O.	5	38	iii. e.	16	15	i. T.	20	14	i.
9	45	iv. t.	11	27	ii. e.	19	22	iii. O.	7	10	i. o.	10	9	27 iii. o.	24	15	9 i.
11	20	i. t.	13	51	ii. E.	21	40	iii. e.	7	54	iii. E.	11	9	i. o.	18	9	i.
11	23	iv. T.	20	42	i. t.	23	57	iii. E.	10	29	i. E.	12	17	iii. O.	18	10	iii
13	36	i. T.	22	58	i. T.	13	3	14 i. o.	19	33	ii. o.	13	38	iii. e.	20	57	iii
14	16	iii. t.	30	17	50 i. o.	6	39	i. E.	28	0	13 ii. E.	14	19	i. E.	21	37	iii
17	10	iii. T.	21	18	i. E.	14	8	ii. o.	4	31	i. t.	15	51	iii. E.	23	47	iii
18	8	28 i. o.				19	3	ii. E.	6	47	i. T.	11	1	i. ii. o.	25	6	33 ii.
11	57	i. E.				14	0	35 i. t.	29	1	40 i. o.	5	23	ii. E.	10	32	ii.
16	54	ii. o.				2	51	i. T.	4	58	i. E.	8	29	i. t.	12	29	i.
19	30	ii. O.				21	44	i. o.	10	8	iv. o.	10	45	i. T.	14	44	i.
19	33	ii. e.				15	1	8 i. E.	11	47	iv. O.	12	5	39 i. o.	26	9	40 i.
21	58	ii. E.				8	18	ii. t.	13	45	ii. t.	8	48	i. E.	12	37	i.
19	5	49 i. t.				10	55	ii. T.	16	21	ii. T.	19	17	ii. t.	27	0	53 ii.
8	5	i. T.				19	4	i. t.	23	1	i. t.	21	53	ii. T.	3	28	ii.
20	2	57 i. o.				21	20	i. T.	30	1	17 i. T.	13	2	59 i. t.	6	59	i.
6	26	i. E.				16	6	31 iii. t.	14	58	iii. t.	5	15	i. T.	9	14	i.
11	2	ii. t.				9	25	iii. T.	17	50	iii. T.	23	33	iii. t.	28	4	10 i.
13	39	ii. T.				16	13	i. o.	20	10	i. o.	14	0	9 i. o.	7	6	i.
21	0	18 i. t.				19	37	i. E.	23	27	i. E.	2	23	iii. T.	8	18	iii
2	34	i. T.				17	3	29 ii. o.	31	8	55 ii. o.	3	17	i. E.	11	4	iii
4	17	iii. o.				8	20	ii. E.	13	31	ii. E.	14	24	ii. o.	19	56	ii.
7	11	iii. O.				13	34	i. t.	17	31	i. t.	18	40	ii. E.	23	49	ii.
9	41	iii. e.				15	50	i. T.	19	46	i. T.	21	29	i. t.	29	1	29 i.
12	3	iii. E.				18	10	42 i. o.				23	45	i. T.	3	45	i.
21	26	i. o.				14	6	i. E.				15	6	0 iv. o.	22	40	i.
22	0	55 i. E.				21	39	ii. t.				7	18	iv. O.	30	1	35 i.
6	12	ii. o.				19	0	15 ii. T.				18	39	i. o.	14	17	ii.
8	48	ii. O.				8	3	i. t.				21	45	i. E.	16	51	ii.
8	51	ii. e.				10	19	i. T.				16	8	41 ii. t.	19	59	i.
11	15	ii. E.				20	38	iii. o.				11	16	ii. T.	22	15	i.
18	46	i. t.				23	32	iii. O.				15	59	i. t.	31	17	10 i.
21	2	i. T.				20	1	39 iii. e.				18	15	i. T.	20	4	i.
23	15	54 i. o.				3	55	iii. E.				17	13	9 i. o.	22	34	iii
19	23	i. E.				5	12	i. o.				13	48	iii. o.			
24	0	20 ii. t.				8	34	i. E.				16	14	i. E.			
2	57	ii. T.				16	50	ii. o.				16	36	iii. O.			
13	15	i. t.				21	38	ii. E.				17	38	iii. e.			
15	31	i. T.				22	40	iv. t.				19	49	iii. E.			
18	14	iii. t.				21	0	24 iv. T.				18	3	47 ii. o.			
21	8	iii. T.				2	33	i. t.				7	57	ii. E.			
25	10	23 i. o.				4	49	i. T.				10	29	i. t.			
13	52	i. E.				23	41	i. o.				12	45	i. T.			
19	31	ii. o.				22	3	3 i. E.				19	7	39 i. o.			
20	22	iv. o.				11	1	ii. t.				10	43	i. E.			
22	7	ii. O.				13	37	ii. T.				22	5	ii. t.			
22	8	iv. O.				21	2	i. t.				20	0	40 ii. T.			
22	9	ii. e.				23	18	i. T.				4	59	i. t.			
26	0	34 ii. E.				23	10	43 iii. t.				7	14	i. T.			
7	44	i. t.				13	36	iii. T.				21	2	9 i. o.			
10	0	i. T.				18	11	i. o.				3	55	iii. t.			
27	4	52 i. o.				21	32	i. E.				5	11	i. E.			

September

Sept. (con.).			November.			Nov. (con.).			Dec. (con.).			Dec. (con.).			Dec. (con.)		
d	h	m	d	h	m	d	h	m	d	h	m	d	h	m	d	h	m
4	9	1 i. E.	12	7	27 i. e.	22	15	54 iii. T.	2	18	49 i. T.	12	9	30 i. e.	22	13	49
	12	42 iii. t.		10	7 i. O.		22	18 i. e.		20	3 ii. e.		12	36 i. O.	23	0	21
	15	27 iii. T.	13	5	6 i. t.	23	1	8 i. O.		23	57 ii. O.	13	7	33 i. t.		3	33
	22	43 ii. o.		7	20 i. T.		20	6 i. t.	3	5	21 iii. e.		9	46 i. T.		22	30
5	2	23 ii. E.		8	7 ii. t.		22	20 i. T.		7	15 iii. E.		11	53 ii. e.	24	0	43
	3	29 i. t.		10	33 ii. T.	24	0	21 ii. t.		8	29 iii. o.		16	2 ii. O.		3	43
	5	45 i. T.	14	1	55 i. e.		2	45 ii. T.		10	34 iii. O.	14	2	51 iii. t.		8	6
6	0	41 i. o.		4	37 i. O.		16	46 i. e.		13	8 i. e.		3	59 i. e.		17	15
	3	30 i. E.		23	36 i. t.		19	38 i. O.		16	7 i. O.		4	49 iii. T.		18	49
	17	7 ii. t.	15	1	40 ii. e.	25	14	36 i. t.		4	11 5 i. t.		7	5 i. O.		19	5
	19	40 ii. T.		1	50 i. T.		16	49 i. T.		13	18 i. T.		15	2 3 i. t.		21	28
	22	0 i. t.		5	4 ii. O.		17	29 ii. e.		16	33 ii. t.		4	16 i. T.		22	2
7	0	15 i. T.		9	17 iii. t.		21	12 ii. O.		18	56 ii. T.		8	42 ii. t.		23	21
	19	11 i. o.		11	32 iii. T.	26	1	23 iii. e.		5	7 37 i. e.		11	4 ii. T.	25	16	59
	21	58 i. E.		20	24 i. e.		3	18 iii. E.		10	37 i. O.		22	27 i. e.		19	12
8	2	59 iii. o.		23	8 i. O.		4	5 iii. o.		6	5 35 i. t.		16	1 35 i. O.	26	0	49
	7	43 iii. E.	16	18	6 i. t.		6	15 iii. O.		7	48 i. T.		20	32 i. t.		3	10
	12	7 ii. o.		20	20 i. T.		11	14 i. e.		9	19 ii. e.		22	45 i. T.		13	17
	15	40 ii. E.		21	32 ii. t.		14	8 i. O.		13	19 ii. O.		17	1 9 ii. e.		16	32
	16	30 i. t.		23	57 ii. T.	27	9	6 i. t.		22	30 iii. t.		5	24 ii. O.	27	11	28
	18	45 i. T.	17	14	52 i. e.		11	19 i. T.		7	0 33 iii. T.		13	17 iii. e.		13	41
9	13	42 i. o.		17	38 i. O.		13	45 ii. t.		2	5 i. e.		15	8 iii. E.		16	59
	16	27 i. E.	18	12	36 i. t.		16	9 ii. T.		5	7 i. O.		16	55 i. e.		21	26
10	6	32 ii. t.		14	50 i. T.	28	5	43 i. e.		8	0 4 i. t.		17	11 iii. o.	28	7	46
	9	5 ii. T.		14	56 ii. e.		8	38 i. O.		2	17 i. T.		19	7 iii. O.		11	1
	11	0 i. t.		18	27 ii. O.	29	3	36 i. t.		5	56 ii. t.		20	5 i. O.		11	25
	13	15 i. T.		21	25 iii. e.		5	49 i. T.		8	19 ii. T.		18	15 2 i. t.		13	15
11	8	12 i. o.		23	21 iii. E.		6	46 ii. e.		20	34 i. e.		17	14 i. T.	29	5	58
	10	56 i. E.		23	39 iii. o.		10	35 ii. O.		23	37 i. O.		22	5 ii. t.		8	10
	17	8 iii. t.	19	1	53 iii. O.		18	7 iii. t.		9	18 34 i. t.		19	0 27 ii. T.		14	11
	19	50 iii. T.		9	21 i. e.		20	14 iii. T.		20	47 i. T.		11	24 i. e.		16	31
12	1	30 ii. o.		12	8 i. O.	30	0	11 i. e.		22	36 ii. e.		14	34 i. O.	30	2	14
	4	57 ii. E.	20	7	6 i. t.		3	8 i. O.		10	2 41 ii. O.		20	9 31 i. t.		5	30
	5	30 i. t.		9	20 i. T.		22	5 i. t.		9	19 iii. e.		11	44 i. T.	31	0	27
	7	45 i. T.		10	57 ii. t.					11	11 iii. E.		14	26 ii. e.		2	39
13	2	42 i. o.		13	22 ii. T.					12	51 iii. o.		18	45 ii. O.		6	16
	5	24 i. E.	21	3	49 i. e.					14	52 iii. O.	21	5	52 i. e.		10	46
	19	57 ii. t.		6	38 i. O.	1	0	19 i. T.		15	2 i. e.		7	9 iii. t.		20	42
	22	30 ii. T.	22	1	36 i. t.		3	9 ii. t.		18	6 i. O.		9	4 iii. T.		21	13
14	0	1 i. t.		3	50 i. T.		5	33 ii. T.		11	13 4 i. t.		9	4 i. O.		23	2
	2	16 i. T.		4	13 ii. e.		18	40 i. e.		15	17 i. T.		22	4 1 i. t.		23	59
	21	13 i. o.		7	50 ii. O.		21	37 i. O.		19	20 ii. t.		6	13 i. T.			
	23	53 i. E.	13	42	iii. t.		2	16 35 i. t.		21	42 ii. T.		11	27 ii. t.			

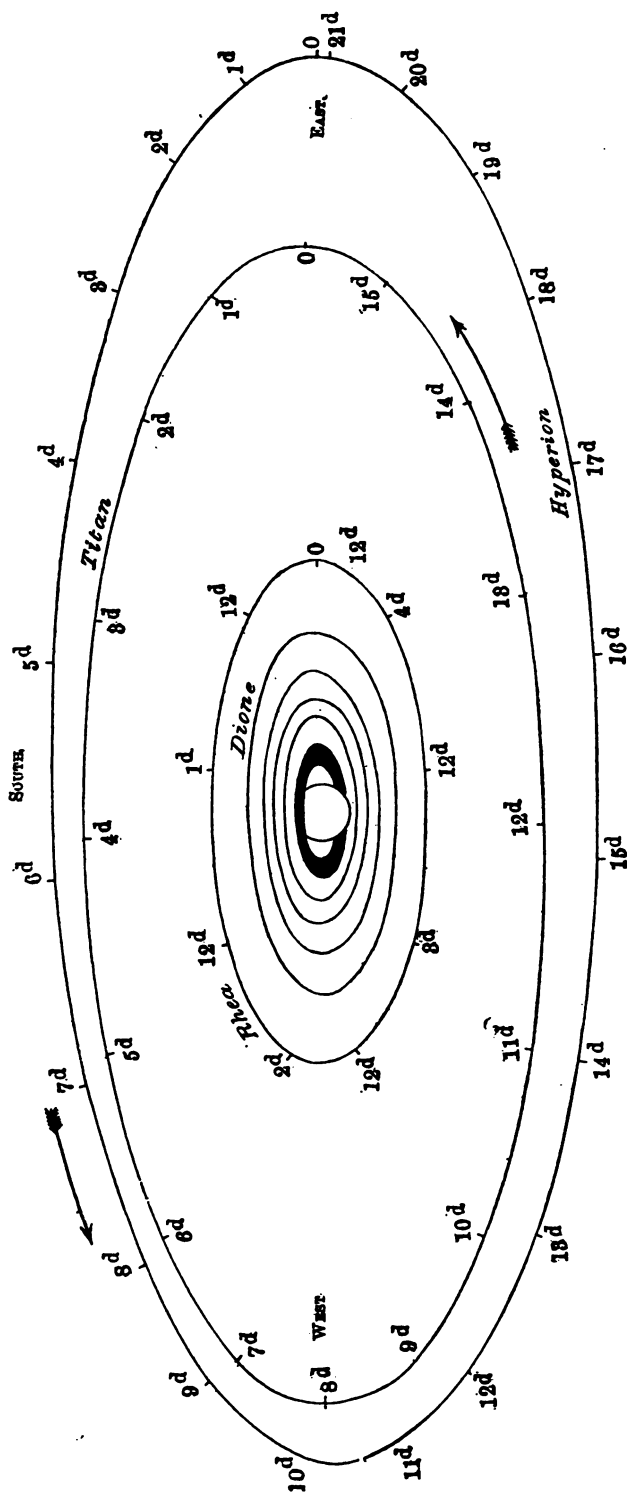
December.

The satellites of Jupiter will be invisible from September 15 until November 12, Jupiter being to the Sun.

Satellites I. & II. disappear at eclipse on the *p* side in January, February, and March. They reappear on the *f* side from April to September. They disappear on the *p* side in November and December.

Satellites III. & IV. disappear and reappear at eclipse on the *p* side in January, February, and March. Satellite III. reappears on the *f* side in April and September. It disappears and reappears on the *f* side from April to August, and on the *p* side in November and December. There is no Eclipse of Satellite IV. from April to December.

APPARENT ORBITS OF THE SEVEN INNER SATELLITES OF SATURN, as seen in an Inverting Telescope.



The arrows in the diagram show the direction of the motion of the satellites. The figures indicate the interval from the time of last East Elongation.

SATELLITES OF SATURN.

East Elongations.

MIMAS.

February.	March.	April.	May.	June.	July.	August.	September
d h	d h	d h	d h	d h	d h	d h	d h
	1 19 ⁰	1 21 ³	1 2 ³	1 4 ⁶	1 8 ²	1 10 ⁷	1 13 ²
	2 17 ⁶	2 19 ⁹	2 0 ⁹	2 3 ²	2 6 ⁸	2 9 ³	2 11 ⁸
	3 16 ²	3 18 ⁵	2 23 ⁵	3 1 ⁸	3 5 ⁴	3 8 ⁰	3 10 ⁴
	4 14 ⁸	4 17 ²	3 22 ¹	4 0 ⁴	4 4 ⁰	4 6 ⁶	4 9 ⁰
	5 13 ⁴	5 15 ⁸	4 20 ⁸	4 23 ⁰	5 2 ⁷	5 5 ²	5 7 ⁷
	6 12 ⁰	6 14 ⁴	5 19 ⁴	5 21 ⁶	6 1 ³	6 3 ⁸	6 6 ³
	7 10 ⁶	7 13 ¹	6 18 ⁰	6 20 ³	6 23 ⁹	7 2 ⁵	7 4 ⁹
	8 9 ²	8 11 ⁷	7 16 ⁷	7 18 ⁹	7 22 ⁶	8 1 ¹	8 3 ⁵
	9 7 ⁸	9 10 ³	8 15 ³	8 17 ⁵	8 21 ²	8 23 ⁷	9 2 ¹
	10 6 ⁴	10 8 ⁹	9 13 ⁹	9 16 ¹	9 19 ⁸	9 22 ³	10 0 ⁷
	11 5 ¹	11 7 ⁵	10 12 ⁵	10 14 ⁸	10 18 ⁵	10 20 ⁹	10 23 ³
	12 3 ⁷	12 6 ¹	11 11 ¹	11 13 ⁴	11 17 ¹	11 19 ⁵	11 22 ⁰
	13 2 ³	13 4 ⁷	12 9 ⁷	12 12 ⁰	12 15 ⁷	12 18 ¹	12 20 ⁶
	14 1 ⁰	14 3 ³	13 8 ³	13 10 ⁶	13 14 ³	13 16 ⁷	13 19 ²
	14 23 ⁶	15 1 ⁹	14 7 ⁰	14 9 ²	14 12 ⁹	14 15 ⁴	14 17 ⁸
	15 22 ²	16 0 ⁵	15 5 ⁶	15 7 ⁸	15 11 ⁵	15 14 ⁰	15 16 ⁵
	16 20 ⁸	16 23 ¹	16 4 ²	16 6 ⁵	16 10 ⁰	16 12 ⁶	16 15 ¹
	17 19 ⁵	17 21 ⁸	17 2 ⁸	17 5 ¹	17 8 ⁷	17 11 ²	17 13 ⁸
	18 18 ¹	18 20 ⁴	18 1 ⁴	18 3 ⁷	18 7 ³	18 9 ⁸	18 12 ⁴
	19 16 ⁷	19 19 ⁰	19 0 ⁰	19 2 ³	19 5 ⁹	19 8 ⁴	19 11 ⁰
	20 15 ³	20 17 ⁶	19 22 ⁶	20 0 ⁹	20 4 ⁵	20 7 ⁰	20 9 ⁶
	21 13 ⁹	21 16 ²	20 21 ³	20 23 ⁵	21 3 ¹	21 5 ⁷	21 8 ²
	22 12 ⁵	22 14 ⁸	21 19 ⁹	21 22 ¹	22 1 ⁷	22 4 ³	22 6 ⁸
	23 11 ¹	23 13 ⁴	22 18 ⁵	22 20 ⁷	23 0 ⁴	23 2 ⁹	23 5 ⁵
	24 9 ⁷	24 12 ⁰	23 17 ¹	23 19 ³	23 23 ⁰	24 1 ⁵	24 4 ¹
	25 8 ³	25 10 ⁶	24 15 ⁷	24 18 ⁰	24 21 ⁷	25 0 ¹	25 2 ⁷
	26 6 ⁹	26 9 ³	25 14 ³	25 16 ⁶	25 20 ³	25 22 ⁷	26 1 ⁴
26 23 ¹	27 5 ⁵	27 7 ⁹	26 12 ⁹	26 15 ²	26 18 ⁹	26 21 ³	27 0 ⁰
27 21 ⁷	28 4 ¹	28 6 ⁵	27 11 ⁵	27 13 ⁸	27 17 ⁶	27 20 ⁰	27 22 ⁶
28 20 ³	29 2 ⁷	29 5 ¹	28 10 ¹	28 12 ⁴	28 16 ²	28 18 ⁷	28 21 ²
	30 1 ³	30 3 ⁷	29 8 ⁷	29 11 ⁰	29 14 ⁸	29 17 ³	29 19 ⁹
	31 0 ⁰		30 7 ³	30 9 ⁶	30 13 ⁴	30 15 ⁰	30 18 ⁵
	31 22 ⁶		31 6 ⁰		31 12 ⁰	31 14 ⁶	

ENCELADUS.

February.	March.	April.	May.	June.	July.	August.	September
d h	d h	d h	d h	d h	d h	d h	d h
	1 14 ⁴	2 2 ⁷	2 6 ¹	1 9 ³	1 12 ⁶	2 0 ⁹	1 4 ⁵
	2 23 ³	3 11 ⁶	3 14 ⁹	2 18 ²	2 21 ⁵	3 9 ⁸	2 13 ⁴
	4 8 ²	4 20 ⁵	4 23 ⁸	4 3 ¹	4 6 ⁴	4 18 ⁷	3 22 ³
	5 17 ¹	6 5 ⁴	6 8 ⁷	5 11 ⁹	5 15 ²	6 3 ⁶	5 7 ²
	7 2 ⁰	7 14 ³	7 17 ⁵	6 20 ⁸	7 0 ¹	7 12 ⁵	6 16 ¹
	8 10 ⁹	8 23 ²	9 2 ⁴	8 5 ⁷	8 9 ⁰	8 21 ⁴	8 1 ⁰
	9 19 ⁷	10 8 ⁰	10 11 ³	9 14 ⁶	9 17 ⁹	10 6 ³	9 9 ⁹
	11 4 ⁶	11 16 ⁹	11 20 ²	10 23 ⁵	11 2 ⁸	11 15 ¹	10 18 ⁸
	12 13 ⁵	13 1 ⁸	13 5 ⁰	12 8 ³	12 11 ⁷	13 0 ⁰	12 3 ⁷
	13 22 ⁴	14 10 ⁶	14 13 ⁹	13 17 ²	13 20 ⁵	14 8 ⁹	13 12 ⁶
	15 7 ³	15 19 ⁵	15 22 ⁸	15 2 ¹	15 5 ⁴	15 17 ⁸	14 21 ⁵
	16 16 ²	17 4 ⁴	17 7 ⁷	16 11 ⁰	16 14 ³	17 2 ⁷	16 6 ⁴
	18 1 ⁰	18 13 ³	18 16 ⁵	17 19 ⁸	17 23 ²	18 11 ⁶	
	19 9 ⁹	19 22 ¹	20 1 ⁴	19 4 ⁷	19 8 ¹	19 20 ⁵	
	20 18 ⁸	21 7 ⁰	21 10 ³	20 13 ⁶	20 16 ⁹	21 5 ⁴	
	22 3 ⁷	22 15 ⁹	22 19 ²	21 22 ⁵	22 1 ⁸	22 14 ³	
	23 12 ⁶	24 0 ⁸	24 4 ¹	23 7 ³	23 10 ⁷	23 23 ¹	
	24 21 ⁵	25 9 ⁷	25 12 ⁹	24 16 ²	24 19 ⁶	25 8 ⁰	
	26 6 ³	26 18 ⁵	26 21 ⁸	26 1 ¹	26 4 ⁵	26 16 ⁹	
24 2 ⁹	27 15 ²	28 3 ⁴	28 6 ⁷	27 10 ⁰	27 13 ⁴	28 1 ⁸	
25 11 ⁸	29 0 ¹	29 12 ³	29 15 ⁵	28 18 ⁹	28 22 ³	29 10 ⁷	
26 20 ⁷	30 9 ⁰	30 21 ²	31 0 ⁴	30 3 ⁷	30 7 ¹	30 19 ⁶	
28 5 ⁵	31 17 ⁸				31 16 ⁰		

East Elongations.

TETHYS.

February.	March.	April.	May.	June.	July.	August.	September.
d h	d h	d h	d h	d h	d h	d h	d h
	2 16.1	1 21.0	2 1.7	1 6.3	1 11.0	2 13.1	1 18.1
	4 13.4	3 18.3	3 22.9	3 3.6	3 8.3	4 10.4	3 15.5
	6 10.7	5 15.6	5 20.2	5 0.9	5 5.6	6 7.7	5 12.8
	8 8.0	7 12.9	7 17.5	6 22.2	7 2.9	8 5.0	7 10.1
	10 5.3	9 10.2	9 14.8	8 19.5	9 0.1	10 2.3	9 7.5
	12 2.6	11 7.5	11 12.1	10 16.7	10 21.4	11 23.6	11 4.8
	13 23.9	13 4.7	13 9.4	12 14.0	12 18.7	13 20.9	13 2.1
	15 21.2	15 2.0	15 6.7	14 11.3	14 16.0	15 18.3	14 23.4
	17 18.5	16 23.3	17 4.0	16 8.6	16 13.3	17 15.6	16 20.7
	19 15.9	18 20.6	19 1.3	18 5.9	18 10.6	19 12.9	18 18.1
	21 13.2	20 17.9	20 22.6	20 3.2	20 7.9	21 10.2	20 15.4
	23 10.5	22 15.2	22 19.8	22 0.5	22 5.2	23 7.5	22 12.7
23 2.9	25 7.8	24 12.5	24 17.1	23 21.8	24 2.5	25 4.9	24 10.1
25 0.2	27 5.1	26 9.8	26 14.4	25 19.1	25 23.8	27 2.2	
26 21.5	29 2.4	28 7.1	28 11.7	27 16.4	27 21.2	28 23.5	
28 18.8	30 23.7	30 4.4	30 9.0	29 13.7	29 18.5	30 20.8	
					31 15.8		

DIONE.

February.	March.	April.	May.	June.	July.	August.	September.
d h	d h	d h	d h	d h	d h	d h	d h
	1 15.5	3 11.7	3 13.9	2 16.1	2 18.2	1 20.7	3 17.1
	4 9.2	6 5.4	6 7.6	5 9.7	5 11.9	4 14.3	6 10.8
	7 2.9	8 23.0	9 1.2	8 3.4	8 5.6	7 8.0	
	9 20.6	11 16.7	11 18.9	10 21.0	10 23.2	10 1.7	
	12 14.3	14 10.3	14 12.5	13 14.7	13 16.9	12 19.4	
	15 7.9	17 4.0	17 6.2	16 8.3	16 10.6	15 13.1	
	18 1.6	19 21.7	19 23.8	19 1.9	19 4.2	18 6.8	
	20 19.3	22 15.3	22 17.5	21 19.6	21 21.9	21 0.5	
	23 13.0	25 9.0	25 11.1	24 13.3	24 15.6	23 18.2	
24 4.1	26 6.7	28 2.6	28 4.8	27 6.9	27 9.3	26 11.9	
26 21.8	29 0.4	30 20.3	30 22.4	30 0.6	30 3.0	29 5.6	
	31 18.0					31 23.3	

RHEA.

February.	March.	April.	May.	June.	July.	August.	September.
d h	d h	d h	d h	d h	d h	d h	d h
	5 11.4	1 13.9	3 4.3	3 18.5	5 8.9	1 11.1	2 2.3
	9 23.8	6 2.2	7 16.6	8 6.8	9 21.2	5 23.6	6 14.8
	14 12.2	10 14.6	12 5.0	12 19.2	14 9.6	10 12.0	11 3.3
	19 0.6	15 2.9	16 17.3	17 7.5	18 21.9	15 0.5	
	23 13.1	19 15.3	21 5.6	21 19.8	23 10.3	19 12.9	
28 22.9	28 1.5	24 3.6	25 17.9	26 8.1	27 22.7	24 1.4	
		28 16.0	30 6.2	30 20.5		28 13.8	

TITAN.

March.	April.	May.	June.	July.	August.
d h	d h	d h	d h	d h	d h
20 8	5 7	7 2	7 21	9 16	13 13
	21 5	23 0	23 19	25 14	26 12

East Elongations.

HYPERION.

February.	March.	April.	May.	June.	July.	August.	September.
d h 27 9	d h 20 12	d h 11 5	d h 2 7 23 10	d h 13 12	d h 5 5 26 9	d h 16 13	d h 7 7 28 12

IAPETUS.

	d h		d h		d h
Inf. Conjunction ...	Apr. 5 14,	June 23 5,	Sept. 10 7.		
W. Elongation.....	Apr. 26 6,	July 13 7,	Oct. 1 5.		
Sup. Conjunction...	Feb. 26 10,	May 16 10,	Aug. 2 12.		
E. Elongation	Mar. 17 14,	June 4 8,	Aug. 22 5.		

Apparent Elements of Saturn's Rings.

Greenwich Mean Noon.	Position-angle of Minor Axis.	Outer Ring.		Latitude above Plane of Ring.	
		Maj. Axis.	Min. Axis.	Earth.	Sun.
Jan. 0	0 44'9	34'68	15'17	25 55'7 N.	25 26'9 N.
20	3 59'6	35'41	15'57	26 4'8 N.	25 32'4 N.
Feb. 9	4 11'0	36'40	16'05	26 9'6 N.	25 37'7 N.
Mar. 1	4 18'1	37'59	16'59	26 10'8 N.	25 42'8 N.
21	4 20'5	38'87	17'13	26 9'3 N.	25 47'8 N.
April 10	4 18'1	40'08	17'63	26 6'0 N.	25 52'5 N.
30	4 11'4	41'04	18'00	26 1'1 N.	25 57'1 N.
May 20	4 1'6	41'57	18'17	25 55'2 N.	26 1'5 N.
June 9	3 50'6	41'57	18'10	25 49'0 N.	26 5'7 N.
29	3 40'5	41'04	17'82	25 44'0 N.	26 9'6 N.
July 19	3 33'4	40'10	17'39	25 41'9 N.	26 13'4 N.
Aug. 8	3 30'7	38'90	16'89	25 44'0 N.	26 17'0 N.
28	3 33'0	37'63	16'40	25 50'4 N.	26 20'5 N.
Sept. 17	3 40'0	36'44	15'98	26 0'5 N.	26 23'8 N.
Oct. 7	3 51'1	35'42	15'65	26 12'7 N.	26 26'8 N.
27	4 5'3	34'66	15'42	26 25'0 N.	26 29'6 N.
Nov. 16	4 21'5	34'18	15'30	26 35'5 N.	26 32'3 N.
Dec. 6	4 38'3	34'02	15'29	26 43'0 N.	26 34'8 N.
26	4 54'6	34'18	15'40	26 46'7 N.	26 37'0 N.
31	4 58'4	34'27	15'44	26 47'0 N.	26 37'6 N.

SATELLITES OF URANUS.

North Elongations.

ARIEL.

March.	April.	May.	June.	July.	August.	September.
d h	d h	d h	d h	d h	d h	d h
	1 3 ⁸	1 9 ⁹	3 4 ⁶	3 10 ⁸	2 16 ⁹	1 22 ⁸
	3 16 ³	3 22 ⁴	5 17 ¹	5 23 ³	5 5 ⁴	4 11 ³
	6 4 ⁸	6 10 ⁹	8 5 ⁷	8 11 ⁸	7 17 ⁹	6 23 ⁷
	8 17 ³	8 23 ⁵	10 18 ²	11 0 ³	10 6 ⁴	9 12 ²
	11 5 ⁸	11 12 ⁰	13 6 ⁷	13 12 ⁸	12 18 ⁹	12 0 ⁷
	13 18 ³	14 0 ⁵	15 19 ²	16 1 ⁴	15 7 ³	14 13 ¹
17 0 ⁸	16 6 ⁹	16 13 ⁰	18 7 ⁷	18 13 ⁹	17 19 ⁸	17 1 ⁶
19 13 ³	18 19 ⁴	19 1 ⁵	20 20 ²	21 2 ⁴	20 8 ³	19 14 ²
22 1 ⁸	21 7 ⁹	21 14 ⁰	23 8 ⁸	23 14 ⁹	22 20 ⁸	22 2 ⁷
24 14 ³	23 20 ⁴	24 2 ⁶	25 21 ³	26 3 ⁴	25 9 ³	24 15 ²
27 2 ⁸	26 8 ⁹	26 15 ¹	28 9 ⁸	28 15 ⁹	27 21 ⁸	27 3 ⁷
29 15 ³	28 21 ⁴	29 3 ⁶	30 22 ³	31 4 ⁴	30 10 ³	29 16 ²
		31 16 ¹				

UMBRIEL.

March.	April.	May.	June.	July.	August.	September.
d h	d h	d h	d h	d h	d h	d h
8 6 ³	2 3 ²	1 3 ⁸	3 8 ¹	2 8 ⁸	4 12 ⁸	2 13 ⁰
12 9 ⁸	6 6 ⁷	5 7 ⁴	7 11 ⁷	6 12 ³	8 16 ³	6 16 ⁴
16 13 ³	10 10 ²	9 10 ⁹	11 15 ²	10 15 ⁸	12 19 ⁷	10 19 ⁹
20 16 ⁸	14 13 ⁷	13 14 ⁵	15 18 ⁷	14 19 ³	16 23 ²	14 23 ²
24 20 ²	18 17 ³	17 18 ⁰	19 22 ²	18 22 ⁸	21 2 ⁶	19 2 ⁷
28 23 ⁷	22 20 ⁸	21 21 ⁵	24 1 ⁸	23 2 ³	25 6 ¹	23 6 ¹
	27 0 ³	26 1 ⁰	28 5 ³	27 5 ⁸	29 9 ⁵	27 9 ⁶
		30 4 ⁶		31 9 ³		

TITANIA.

February.	March.	April.	May.	June.	July.	August.	September.
d h	d h	d h	d h	d h	d h	d h	d h
27 9 ⁸	8 2 ⁷	3 5 ⁸	8 2 ⁷	3 6 ⁶	8 3 ⁴	3 6 ⁶	7 2 ¹
	16 19 ⁶	11 23 ⁰	16 20 ⁰	11 23 ⁸	16 20 ⁵	11 23 ⁵	15 18 ⁹
	25 12 ⁷	20 16 ²	25 13 ³	20 17 ¹	25 13 ⁶	20 16 ⁴	24 11 ⁶
		29 9 ⁵		29 10 ³		29 9 ³	

OBERON.

March.	April.	May.	June.	July.	August.
d h	d h	d h	d h	d h	d h
13 8 ²	9 7 ¹	6 6 ⁹	2 6 ⁸	12 17 ⁹	8 16 ⁵
26 19 ⁵	22 18 ⁹	19 18 ⁸	15 18 ⁶	26 5 ³	22 3 ⁵
			29 6 ³		

Position-angle and distance of the apse of Oberon:—March 1, 339° 3.43' 2; May 20, 343° 3.45' 2; August 8, 347° 1.43' 4.

SATELLITE OF NEPTUNE.

East Elongations.

January.	February.	March.	September.	October.	November.	December.
d h	d h	d h	d h	d h	d h	d h
1 8 ³	5 15 ¹	7 0 ⁴	10 23 ⁵	4 11 ⁶	2 20 ⁹	2 6 ⁴
7 5 ⁴	11 12 ¹	12 21 ⁴	16 20 ⁵	10 8 ⁶	8 18 ⁰	8 3 ⁵
13 2 ⁶	17 9 ²	18 18 ⁴	22 17 ⁵	16 5 ⁷	14 15 ¹	14 0 ⁷
18 23 ⁷	23 6 ³	24 15 ⁴	28 14 ⁶	22 2 ⁸	20 12 ²	19 21 ⁸
24 20 ⁸	29 3 ³	30 12 ⁴		27 23 ⁹	26 9 ³	25 18 ⁹
30 17 ⁹						31 16 ¹

Position-angle and distance of the apse:—March 5, 255° 2.16' 4; Sept. 21, 260° 7.16' 4; December 10, 259° 3.16' 9.

**EPHEMERIS FOR PHYSICAL OBSERVATIONS
OF THE SUN.**

Greenwich Mean Noon.				Greenwich Mean Noon.			
1898.	P.	D.	L.	1898.	P.	D.	L.
Jan. 1	+ 0 39	- 3 18	309 11	July 5	- 0 35	+ 3 33	27 16
6	- 0 47	3 52	243 19	10	+ 1 42	4 4	321 5
11	3 12	4 23	177 28	15	3 58	4 33	254 57
16	5 34	4 53	111 37	20	6 10	5 0	188 48
21	7 53	5 20	45 47	25	8 19	5 26	122 39
26	10 6	5 45	339 58	30	10 23	5 48	56 31
31	12 13	6 7	274 8	Aug. 4	12 22	6 9	350 24
Feb. 5	14 13	6 27	208 17	9	14 15	6 27	284 17
10	16 5	6 43	142 25	14	16 2	6 42	218 11
15	17 49	6 56	76 35	19	17 42	6 55	152 7
20	19 25	7 5	10 46	24	19 14	7 4	86 2
25	20 52	7 12	304 55	29	20 39	7 11	19 58
Mar. 2	22 10	7 15	239 3	Sept. 3	21 55	7 14	313 56
7	23 17	7 14	173 9	8	23 3	7 15	247 54
12	24 16	7 11	107 16	13	24 2	7 12	181 53
17	25 4	7 4	41 23	18	24 51	7 6	115 52
22	25 41	6 54	335 27	23	25 31	6 57	49 54
27	26 8	6 41	269 31	28	26 1	6 45	343 53
Apr. 1	26 25	6 25	203 32	Oct. 3	26 21	6 30	277 56
6	26 30	6 6	137 34	8	26 30	6 12	211 59
11	26 25	5 44	71 34	13	26 27	5 51	146 1
16	26 8	5 20	5 33	18	26 14	5 27	80 4
21	25 41	4 54	299 30	23	25 49	5 1	14 7
26	25 2	4 26	233 25	28	25 12	4 32	308 11
May 1	24 12	3 56	167 21	Nov. 2	24 23	4 2	242 16
6	23 12	3 24	101 15	7	23 23	3 30	176 20
11	22 1	2 51	35 9	12	22 11	2 55	110 24
16	20 39	2 17	329 0	17	20 47	2 20	44 28
21	19 8	1 42	262 51	22	19 12	1 43	338 35
26	17 29	1 6	196 42	27	17 26	1 6	272 42
31	15 41	- 0 30	130 33	Dec. 2	15 31	+ 0 27	206 48
June 5	13 45	+ 0 6	64 23	7	13 28	- 0 11	140 54
10	11 43	0 42	358 11	12	11 17	0 49	75 1
15	9 35	1 18	292 0	17	9 0	1 27	9 11
20	7 23	1 53	225 49	22	6 38	2 5	303 18
25	5 8	2 28	159 38	27	4 13	2 41	237 27
30	- 2 52	+ 3 1	93 28	32	+ 1 46	- 3 17	171 36

The position-angle of the Sun's axis, P, is the position-angle of the N. end of the axis from the N. point of the Sun, read in the direction N., E., S., W. In computing D (the heliographic latitude of the centre of the Sun's disk), the inclination of the Sun's axis to the ecliptic has been assumed to be $82^{\circ} 45'$, and the longitude of the ascending node to be $74^{\circ} 22'$. In computing L (the heliographic longitude of the centre of the disk), the Sun's period of rotation has been assumed to be 25.38 days, and the meridian which passed through the ascending node at the epoch 1854.0 has been taken as the zero meridian.

MEAN PLACES OF VARIABLE STARS FOR 1898.0.

No.	Star.	R.A.			Dec.	No.	Star.	R.A.			Dec.
		h	m	s	°			h	m	s	°
1.	V Sculptoris ...	0	3	28	-39 47.8	53.	V Aurigæ	6	16	9	+47 42.7
2.	S Sculptoris ...	0	10	13	-32 36.8	54.	V Monocerotis...	6	17	35	-2 8.6
3.	T Andromedæ ...	0	17	4	+26 25.8	55.	T Monocerotis...	6	19	43	+7 8.5
4.	T Cassiopeia ...	0	17	43	+55 13.6	56.	W Geminorum ...	6	29	7	+15 24.6
5.	S Toucani	0	18	18	-62 14.7	57.	S Monocerotis...	6	35	22	+9 59.2
6.	R Andromedæ ...	0	18	39	+38 0.8	58.	W Monocerotis...	6	47	24	-7 1.5
7.	S Ceti	0	18	52	-9 53.6	59.	R Lyncis	6	52	53	+55 28.5
8.	U Cassiopeia ...	0	40	39	+47 42.0	60.	Z Geminorum ...	6	58	4	+20 43.2
9.	W Cassiopeia ...	0	48	51	+58 0.7	61.	R Geminorum ...	7	1	13	+22 51.7
10.	U Cephei	0	53	14	+81 19.6	62.	V Canis Min. ...	7	1	26	+9 1.7
11.	U Sculptoris ...	1	6	44	-30 39.4	63.	R Canis Min. ...	7	3	6	+10 11.1
11a	U Andromedæ ...	1	9	40	+40 10.8	64.	L ² Puppis	7	10	25	-44 28.6
12.	S Cassiopeia ...	1	12	9	+72 4.5	65.	R Canis Maj. ...	7	14	51	-16 12.2
13.	S Piscium	1	12	14	+8 23.6	66.	V Geminorum ...	7	17	27	+13 17.3
14.	U Piscium	1	17	35	+12 20.0	67.	U Monocerotis...	7	25	56	-9 33.8
15.	R Sculptoris ...	1	22	16	-33 4.3	68.	S Canis Min. ...	7	27	11	+8 32.2
16.	R Piscium	1	25	22	+2 21.3	69.	T Canis Min. ...	7	28	20	+11 57.8
17.	X Cassiopeia ...	1	49	37	+58 45.5	70.	X Puppis	7	28	21	-20 41.5
18.	U Persei	1	52	48	+54 19.6	71.	U Canis Min. ...	7	35	48	+8 37.1
19.	S Arietis	1	59	9	+12 2.2	72.	S Geminorum ...	7	36	56	+23 41.4
20.	R Arietis	2	10	19	+24 34.9	73.	T Geminorum ...	7	43	11	+23 59.3
21.	o Ceti	2	14	12	-3 26.4	74.	U Geminorum ...	7	49	3	+22 16.2
22.	R Ceti	2	20	49	-0 38.3	75.	V Puppis	7	55	19	-48 58.1
23.	S Horologii	2	22	19	-60 1.7	76.	U Puppis	7	56	3	-12 33.5
24.	U Ceti	2	28	50	-13 35.8	77.	R Cancri	8	10	57	+12 2.4
25.	R Trianguli ...	2	30	51	+33 49.2	78.	V Cancri	8	15	54	+17 36.5
26.	T Arietis	2	42	38	+17 5.1	79.	V Carinae	8	26	39	-59 46.7
27.	V Persei	2	43	6	+56 33.6	80.	X Carinae	8	29	4	-58 52.8
28.	R Horologii ...	2	49	38	-50 21.8	81.	U Cancri	8	29	56	+19 14.9
29.	Algol	3	1	32	+40 33.8	82.	T Velorum	8	34	22	-47 0.3
30.	U Arietis	3	5	24	+14 24.8	83.	S Cancri	8	38	7	+19 24.1
31.	R Persei	3	23	33	+35 19.2	84.	R Mali	8	41	12	-27 49.8
32.	T Eridani	3	50	52	-24 19.9	85.	S Hydræ	8	48	15	+3 27.2
33.	λ Tauri	3	55	2	+12 12.2	86.	T Hydræ	8	50	42	-8 45.1
34.	W Tauri	4	22	12	+15 52.7	87.	T Cancri	8	50	51	+20 14.4
35.	R Tauri	4	22	43	+9 56.1	88.	W Cancri	9	3	55	+25 39.8
36.	S Tauri	4	23	37	+9 43.2	89.	W Carinae	9	19	11	-55 31.4
37.	T Camelopardi ...	4	30	10	+65 56.5	90.	S Antliae	9	27	51	-28 10.7
38.	R Reticuli	4	32	29	-63 14.4	91.	N Velorum	9	28	7	-56 35.1
39.	V Tauri	4	46	7	+17 22.0	92.	U Velorum	9	29	23	-45 3.7
40.	R Orionis	4	53	28	+7 58.6	93.	S Velorum	9	29	23	-44 45.4
41.	R Leporis	4	54	58	-14 57.6	94.	R Carinae	9	29	41	-62 20.2
42.	T Leporis	5	0	30	-22 2.6	95.	X Hydræ	9	30	38	-14 14.2
43.	V Orionis	5	0	41	+3 57.8	96.	R Leo. Min. ...	9	39	28	+34 58.9
44.	S Pictoris	5	8	15	-48 37.9	97.	R Leonis	9	42	5	+11 54.1
45.	R Aurigæ	5	9	4	+53 28.3	98.	l Carinae	9	42	27	-62 2.2
46.	T Columbae	5	15	33	-33 48.8	99.	V Leonis	9	54	22	+21 44.9
47.	S Orionis	5	23	58	-4 46.4	100.	S Carinae	10	6	7	-61 3.0
48.	S Camelopardi ...	5	30	0	+68 44.5	101.	Y Carinae	10	29	20	-57 58.3
49.	U Aurigæ	5	35	31	+31 59.4	102.	R Ursæ Maj. ...	10	37	26	+69 18.6
50.	R Columbae	5	46	35	-29 13.2	103.	V Hydræ	10	46	39	-20 41.9
51.	U Orionis	5	49	46	+20 9.4	104.	W Leonis	10	48	15	+14 15.5
52.	η Geminorum ...	6	8	43	+22 32.2	105.	U Carinae	10	53	39	-59 11.2

Mean Places of Variable Stars for 1898.0 (continued).

No.	Star.	R.A.			Dec.	No.	Star.	R.A.			Dec.
		h	m	s				h	m	s	
106.	S Leonis	11	5	34	+ 6 0'9	161.	Z Libræ	15	40	34	-20 48'2
107.	S ² Centauri	11	16	1	-61 18'9	162.	V Coronæ	15	45	53	+39 52'7
108.	X Centauri	11	44	6	-41 11'3	163.	R Serpentis.....	15	46	0	+15 26'6
109.	W Centauri	11	49	56	-58 41'1	164.	R Libræ	15	47	49	-15 56'0
110.	R Comæ	11	59	1	+19 21'2	165.	R ² Libræ.....	15	50	32	-18 0'3
111.	S Muscæ	12	7	18	-69 35'0	166.	S Triang. Austr.	15	52	1	-63 29'1
112.	T Virginis	12	9	23	-5 28'1	167.	U Triang. Austr.	15	58	14	-62 37'9
113.	R Corvi	12	14	21	-18 41'3	168.	X Herculis	15	59	35	+47 31'1
114.	T Crucis	12	15	47	-61 42'9	169.	Z Scorpil	16	0	1	-21 27'3
115.	R Crucis	12	18	2	-61 3'8	170.	R Herculis	16	1	38	+18 38'8
116.	Y Virginis	12	28	37	-3 51'6	171.	X Scorpil	16	2	33	-21 15'1
117.	T Ursæ Maj.	12	31	45	+60 2'9	172.	W Scorpil	16	5	48	-19 52'3
118.	R Virginis	12	33	20	+ 7 33'0	173.	S Normæ	16	10	25	-57 38'8
119.	R Muscæ	12	35	51	-68 50'9	174.	R Scorpil	16	11	34	-22 41'6
120.	S Ursæ Maj.	12	39	29	+61 39'1	175.	S Scorpil	16	11	35	-22 38'5
121.	U Virginis	12	45	55	+ 6 6'5	176.	W Ophiuchi	16	15	55	-7 27'3
122.	S Crucis	12	48	20	-57 52'6	177.	V Ophiuchi	16	21	3	-12 11'7
123.	W Virginis	13	20	46	-2 51'0	178.	U Herculis	16	21	18	+19 7'2
124.	V Virginis	13	22	32	-2 38'7	179.	Y Scorpil	16	23	42	-19 13'0
125.	R Hydræ	13	24	9	-22 45'2	180.	T Ophiuchi.....	16	27	54	-15 54'8
126.	S Virginis	13	27	40	-6 40'2	181.	S Ophiuchi.....	16	28	23	-16 56'7
127.	Z Centauri	13	34	10	-31 7'0	182.	R Aræ.....	16	31	16	-56 47'3
128.	T Centauri	13	35	55	-33 4'9	183.	W Herculis.....	16	31	37	+37 32'9
129.	W Hydræ	13	43	14	-27 51'4	184.	Y Herculis	16	31	54	+ 7 18'9
130.	R Canum Ven.	13	44	34	+40 3'0	185.	R Draconis	16	32	23	+66 58'0
131.	R ² Virginis	13	59	28	-8 42'5	186.	S Herculis	16	47	15	+15 6'8
132.	Z Virginis	14	4	51	-12 49'2	187.	S ² Scorpil	16	48	14	-44 56'1
133.	R Centauri	14	9	13	-59 26'3	188.	R ² Scorpil	16	50	8	-30 25'0
134.	R ² Centauri	14	9	46	-57 22'7	189.	V ² Scorpil	16	51	40	-33 27'0
135.	Y Boötis	14	17	17	+20 16'3	190.	R Ophiuchi.....	17	1	54	-15 57'4
136.	X Boötis	14	19	21	+16 47'0	191.	W ² Scorpil	17	8	10	-33 18'8
137.	S Boötis	14	19	28	+54 16'5	192.	U Ophiuchi.....	17	11	21	+ 1 19'4
138.	S ² Virginis	14	22	10	+ 5 8'1	193.	Z Ophiuchi.....	17	14	22	+ 1 37'4
139.	V Centauri	14	25	14	-56 26'1	194.	S ² Herculis.....	17	17	26	+23 1'2
140.	R Camelopardi.	14	25	16	+84 17'7	195.	U ² Scorpil	17	34	57	-43 42'2
141.	V Boötis	14	25	38	+39 19'0	196.	X Sagittarii	17	41	8	-27 47'5
142.	R Boötis	14	32	42	+27 10'7	197.	Y ² Scorpil	17	44	8	-33 40'5
143.	V Libræ	14	34	41	-17 13'1	198.	Y Ophiuchi.....	17	47	11	-6 7'1
144.	S Lupi.....	14	46	34	-46 11'5	199.	Z Herculis	17	53	31	+15 8'4
145.	U Boötis	14	49	37	+18 6'6	200.	T Draconis	17	54	50	+58 13'7
146.	δ Libræ	14	55	32	-8 6'8	201.	W Sagittarii	17	58	31	-29 35'2
147.	T Triang. Austr.	15	0	9	-68 19'3	202.	T Herculis	18	5	14	+31 0'1
148.	T Libræ	15	4	55	-19 37'8	203.	S ² Sagittarii	18	10	50	-34 8'6
149.	Y Libræ	15	6	18	-5 37'5	203a.	W Lyræ	18	11	24	+36 38'3
150.	R Triang. Austr.	15	10	39	-66 7'3	204.	Y Sagittarii.....	18	15	23	-18 54'3
151.	U Coronæ	15	14	2	+32 1'2	205.	V ² Sagittarii	18	21	13	-33 22'7
152.	S Libræ	15	15	31	-20 1'2	206.	d Serpentis.....	18	21	59	+ 0 8'1
153.	S Serpentis.....	15	16	53	+14 40'8	207.	T Serpentis.....	18	23	50	+ 6 13'8
154.	S Coronæ	15	17	14	+31 44'1	208.	U Sagittarii	18	25	53	-19 11'9
155.	S ² Libræ.....	15	18	22	-22 32'8	209.	X Ophiuchi	18	33	29	+ 8 44'3
156.	U ² Libræ.....	15	27	34	-14 58'9	210.	U Coron. Austr.	18	34	9	-37 55'7
157.	X Libræ	15	30	19	-20 49'5	211.	R Scuti	18	42	3	-5 48'9
158.	W Libræ.....	15	32	5	-15 50'2	212.	β Lyræ	18	46	19	+33 14'6
159.	S Ursæ Majoris ..	15	33	32	+78 58'7	213.	ε Pavonis	18	46	26	-67 21'7
160.	U Libræ	15	36	6	-20 51'1	214.	R Lyræ	18	52	14	+43 48'6

Mean Places of Variable Stars for 1898.0 (continued).

No.	Star.	R.A.			Dec.	No.	Star.	R.A.			Dec.
		h	m	s	°			h	m	s	°
215.	R Coron. Austr.	18	55	1	-37 5'8	256.	U Capricorni ...	20	42	28	-15 9'5
216.	R Aquilæ	19	1	27	+ 8 4'6	257.	R ² Cygni.....	20	42	33	+44 29'8
217.	Y Aquilæ	19	2	10	+10 54'8	258.	V Delphini.....	20	43	8	+18 57'6
218.	V Lyræ	19	5	5	+29 29'8	259.	T Aquarii	20	44	33	- 5 31'5
219.	S Lyræ	19	9	2	+25 49'8	260.	U Pavonis	20	47	0	-63 5'6
220.	W Aquilæ	19	9	53	- 7 13'2	261.	T Vulpeculæ ...	20	47	9	+27 51'8
221.	T Sagittarii ...	19	10	21	-17 9'0	262.	Y Cygni	20	48	0	+34 16'5
222.	R Sagittarii ...	19	10	43	-19 29'2	263.	X Delphini.....	20	50	12	+17 13'9
223.	S Sagittarii.....	19	13	28	-19 12'6	264.	R Vulpeculæ ...	20	59	51	+23 25'0
224.	Z Sagittarii.....	19	13	40	-21 6'8	265.	V Capricorni ...	21	1	41	-24 20'1
225.	T Sagittæ	19	17	9	+17 27'6	266.	X Capricorni ...	21	2	43	-21 45'6
226.	U Aquilæ	19	23	52	- 7 15'2	267.	Z Capricorni ...	21	4	56	-16 35'7
227.	R Cygni	19	34	5	+49 58'3	268.	T Cephei.....	21	8	12	+68 4'6
228.	T Pavonis	19	39	17	-72 1'0	269.	T Capricorni ...	21	16	23	-15 35'4
229.	T ² Cygni.....	19	40	46	+48 31'6	270.	Y Capricorni ...	21	28	49	-14 25'6
230.	S Vulpeculæ ...	19	44	13	+27 2'0	271.	W Cygni.....	21	32	11	+44 55'1
231.	X Aquilæ.....	19	46	25	+ 4 12'2	272.	S Cephei	21	36	29	+78 9'9
232.	χ Cygni	19	46	39	+32 39'4	273.	U ² Cygni.....	21	37	12	+53 51'8
233.	η Aquilæ.....	19	47	17	+ 0 44'6	274.	R ³ Cygni.....	21	38	42	+43 7'0
234.	R ² Sagittarii ...	19	49	36	-29 27'3	275.	R Gruis	21	41	58	-47 22'5
235.	S Sagittæ	19	51	23	+16 21'8	276.	U Aquarii	21	57	46	-17 7'1
236.	R ² Aquilæ	19	52	19	- 2 11'4	277.	S Piscis Austr. .	21	57	55	-28 32'6
237.	Z Cygni	19	58	34	+49 45'5	278.	T Pegasi	22	3	55	+12 2'5
238.	S Cygni	20	3	22	+57 41'5	279.	R Piscis Austr. .	22	12	12	-30 6'8
239.	R Capricorni ...	20	5	35	-14 34'3	280.	X Aquarii	22	13	3	-21 24'6
240.	S Aquilæ.....	20	6	56	+15 19'0	281.	S Gruis	22	19	48	-48 57'4
241.	W Capricorni...	20	8	29	-22 17'3	282.	S Lacertæ	22	24	32	+39 47'6
242.	R Sagittæ	20	9	24	+16 25'0	283.	δ Cephei	22	25	23	+57 53'6
243.	Z Aquilæ.....	20	9	45	- 6 27'7	284.	W Cephei	22	32	34	+57 54'0
244.	R Delphini.....	20	10	0	+ 8 46'8	285.	R Lacertæ	22	38	45	+41 50'2
245.	T ² Sagittarii ...	20	10	57	-39 25'6	286.	S Aquarii	22	51	39	-20 53'3
246.	U Cygni	20	16	27	+47 34'3	287.	R Pegasi	23	1	32	+ 9 59'6
247.	W Delphini.....	20	33	2	+17 55'5	288.	V Cassiopeiæ ..	23	7	17	+59 7'8
248.	R Microscopii...	20	33	51	-29 9'0	289.	S Pegasi	23	15	23	+ 8 21'7
249.	V Cygni	20	38	1	+47 46'6	290.	R Aquarii	23	38	33	-15 51'0
250.	S Delphini.....	20	38	23	+16 43'3	291.	V Cephei.....	23	51	39	+82 37'4
251.	Y Aquarii	20	39	3	- 5 12'5	292.	V Ceti	23	52	41	- 9 31'7
252.	X Cygni	20	39	25	+35 13'1	293.	U Pegasi	23	52	46	+15 23'2
253.	T Delphini.....	20	40	38	+16 1'7	294.	R Cassiopeiæ ...	23	53	13	+50 49'2
254.	W Aquarii	20	41	4	- 4 27'4	295.	W Ceti	23	56	54	-15 44'6
255.	V Aquarii	20	41	40	+ 2 3'9						

(The No. after Star's Name refers to Catalogue on pp. 24-26.)

Note.—The times of minima only are given; the times of maxima may be found by adding the interval printed under the name of the star.

[illegible]

VARIABLES OF SHORT PERIOD (*continued*).

♐ AQUILÆ 226. (2 ^d 4½ ^h .)			♐ AQUILÆ 233 (<i>continued</i>).			♐ SAGITTÆ 235 (<i>continued</i>).			♐ VULPEC. 261. (1 ^d 9½ ^h .)			♐ CEPHEI 283 (1 ^d 14½ ^h .)		
Feb.	May	Sept.	Apr.	July	Oct.	June	Aug.	Oct.	Jan.	May	Sept.	Jan.	May	Sept.
d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h
4 21 13	3 22	7 5	2 8	3 15	4 21	2 14	8 15	2 10	2 5	3 10	1 23	5 9	5	
5 28 14	10 22	14 9	9 12	10 19	13 6	10 23	17 0	6 21	6 15	7 20	7 7	10 18	11	
6 17 23	21 14	16 16	17 23	21 16	19 8	25 10	11 7	11 2	12 6	12 16	16 2	16		
6 4 14	24 23	28 18	23 21	25 4	30 1	27 17	Nov.	15 18	15 12	16 17	18 1	21 11	21	
7 11 15	Oct.		31 1	Nov.			2 19	20 4	19 23	21 3	23 10	26 20	27	
7 18 15	2 0						11 4	24 15	24 9	25 14	28 19			
7 25 16	9 1	5 22		Aug.	1 8	July	Sept.	29 1	28 20	30 1				
8 9 1	13 2	7 5	8 12											
8 16 1	14 9	15 16	8 10	5 2	27 22			Feb.	June	Oct.	Feb.	1 5	2	
8 23 2	20 7	21 14	16 19	13 12	Dec.			2 12	2 6	4 11	3 3	6 13	8	
8 30 2	27 11	28 18	30 1	25 4	21 21	6 7		6 22	6 17	8 22	8 12	11 22	13	
9 9 17					30 6	14 17		11 8	11 3	13 8	13 21	17 7	18	
9 16 18	Nov.	June	Sept.	Dec.				15 19	15 13	17 18	19 6	22 16	24	
9 23 18	6 3	3 15	4 22	7 5				20 5	20 0	22 5	24 14	28 1	29	
9 30 19	13 3	10 19	12 2	14 9				24 16	24 10	26 15	28 21	31 2		
10 3 11	Aug.	20 4	17 23	19 6	21 14				28 21	31 2				
10 6 19	27 5	25 4	26 11	28 18				Mar.	July	Nov.	Mar.	July	No	
10 13 20	Dec.							1 2	3 7	4 12	1 23	3 9	3	
10 20 21	4 5							5 13	7 18	8 23	7 8	8 18	9	
10 27 21								9 23	12 4	13 9	12 17	14 3	14	
								14 10	16 15	17 20	18 2	19 12	19	
								18 20	21 1	22 6	23 10	24 21	25	
								23 7	25 12	26 17	28 19	30 5	30	
								27 17	29 22					
								Apr.	Aug.	Dec.	Apr.	Aug.	De	
								1 4	3 9	1 3	3 4	4 14	5	
								5 14	7 19	5 14	8 13	9 23	10	
								10 0	12 5	10 0	13 22	15 8	16	
								14 11	16 16	14 10	17 6	20 17	22	
								18 21	21 2	18 21	24 15	26 1	27	
								23 8	25 13	23 7	30 0	31 10		
								27 18	29 23	27 18				

MAGNETIC ELEMENTS, ROYAL OBSERVATORY, GREENWICH.

Year.	Declination.	Horizontal force.	Dip.
1870, observed	19 53 west.	0°1782	67 52
1880, "	18 33 "	0°1804	67 36
1890, "	17 29 "	0°1823	67 23
1898, inferred	16 39 "	0°1837	67 12

The horizontal force is given in C. G. S. measure.

† Every third minimum only.

Minima of Variable Stars of the Algol Type (continued).

R CANIS MAJ. 65†
(continued).

Sept.	Nov.
d h m	d h m
1 12 32	1 20 44
4 22 20	5 6 31
8 8 7	8 16 18
11 17 54	12 2 6
15 3 42	15 11 53
18 13 29	18 21 40
21 23 16	22 7 28
25 9 3	25 17 14
28 18 51	29 3 1
Oct.	Dec.
d h m	d h m
2 4 38	2 12 49
5 14 25	5 22 37
9 0 13	9 8 24
12 10 0	12 18 11
15 19 47	16 3 59
19 5 35	19 13 46
22 15 22	22 23 33
26 1 9	26 9 21
29 10 56	29 19 8

S CANCRI 83.

Jan.	June.
d h m	d h m
8 0 33	18 6 15
17 12 11	27 17 53
26 23 49	
Feb.	July.
d h m	d h m
5 11 26	7 5 30
14 23 4	16 17 8
24 10 42	26 4 46
March.	Sept.
d h m	d h m
5 22 20	2 3 17
15 9 57	11 14 55
24 21 35	21 2 32
	30 14 10
April.	Oct.
d h m	d h m
3 9 13	10 1 48
12 20 51	19 13 26
22 8 28	29 1 3
May.	Nov.
d h m	d h m
1 20 6	7 12 41
11 7 44	17 0 19
20 19 22	26 11 57
30 6 59	
June.	Dec.
d h m	d h m
8 18 37	5 23 34
	15 11 12
	24 22 50

δ LIBRÆ 146*.
(2^d 7^h 51^m.)

Jan.	June.
d h m	d h m
2 8 36	4 23 7
7 0 19	9 14 50
11 16 2	14 6 33
16 7 45	18 22 16
20 23 27	23 13 58
25 15 10	28 5 41
30 6 53	
Feb.	July.
d h m	d h m
3 22 36	2 21 24
8 14 18	7 13 7
13 6 1	12 4 49
17 21 44	16 20 32
22 13 27	21 12 15
27 5 9	26 3 58
	30 19 40
March.	August.
d h m	d h m
3 20 52	4 11 23
8 12 35	9 3 6
13 4 18	13 18 49
17 20 0	18 10 32
22 11 43	23 2 14
27 3 26	27 17 57
31 19 9	
April.	Sept.
d h m	d h m
5 10 51	1 9 40
10 2 34	6 1 23
14 18 17	10 17 5
19 10 0	15 8 48
24 1 43	20 0 31
28 17 25	24 16 14
	29 7 56

U CORONÆ 151*.
(3^d 10^h 51^m.)

Jan.	Feb.
d h m	d h m
3 8 36	6 21 6
10 6 18	13 18 48
17 4 0	20 16 31
24 1 42	27 14 13
30 23 24	

U CORONÆ 151*
(continued).

March.	August.
d h m	d h m
6 11 55	5 9 20
13 9 37	12 7 2
20 7 19	19 4 44
27 5 1	26 2 26
April.	Sept.
d h m	d h m
3 2 43	2 0 8
10 0 25	8 21 50
16 22 7	15 19 32
23 19 49	22 17 14
30 17 31	29 14 56
May.	Oct.
d h m	d h m
7 15 13	6 12 38
14 12 55	13 10 20
21 10 37	20 8 2
28 8 19	27 5 44
June.	Nov.
d h m	d h m
4 6 1	3 3 27
11 3 43	10 1 9
18 1 25	16 22 51
24 23 8	23 20 33
	30 18 15
July.	Dec.
d h m	d h m
1 20 50	7 15 57
8 18 32	14 13 39
15 16 14	21 11 21
22 13 56	28 9 3
29 11 38	

U OPHIUCHI 192‡.

$\begin{cases} 1 = 0^d 20^h 8^m \\ 2 = 1 16 16 \\ 3 = 2 12 23 \end{cases}$	
Jan.	Feb.
d h m	d h m
1 6 37	17 5 50
4 15 8	20 14 21
7 23 39	23 22 52
11 8 10	27 7 23
14 16 41	
18 1 12	
21 9 43	
24 18 14	
28 2 45	
31 11 16	
March.	
d h m	d h m
2 15 54	
6 0 25	
9 8 56	
12 17 26	
16 1 57	
19 10 28	
22 18 59	
26 3 30	
29 12 1	

* Alternate minima only are given; the others can be readily found by adding the interval under the name of the star.

† Every third minimum only.

‡ Every fourth minimum only.

Minima of Variable Stars of the Algol Type (continued).

U OPHIOCHI 192 †
(continued).

April.	July.
d h m	d h m
1 20 32	18 5 1
5 5 3	21 13 32
8 13 34	24 22 3
11 22 5	28 6 34
15 6 36	31 15 5
18 15 6	
21 23 37	August.
25 8 8	3 23 36
28 16 39	7 8 6
	10 16 37
May.	14 1 8
2 1 10	17 9 39
5 9 41	20 18 10
8 18 12	24 2 41
12 2 43	27 11 12
15 11 14	30 19 43
18 19 45	
22 4 16	Sept.
25 12 46	3 4 14
28 21 17	6 12 45
	9 21 16
June.	13 5 47
1 5 48	16 14 17
4 14 19	19 22 48
7 22 50	23 7 19
11 7 21	26 15 50
14 15 52	30 0 21
18 0 23	
21 8 54	Oct.
24 17 25	3 8 52
28 1 56	6 17 23
	10 1 54
July.	13 10 25
1 10 26	16 18 56
4 18 57	20 3 27
8 3 28	23 11 58
11 11 59	26 20 28
14 20 30	30 4 59

Z HERCULIS 199 †.

$$\left\{ \begin{array}{l} 1=1^d 21^h 19^m \\ 2=3 23 49 \\ 3=5 21 8 \end{array} \right\}$$

Jan.	Feb.
d h m	d h m
2 4 26	3 3 2
10 4 5	11 2 41
18 3 44	19 2 20
26 3 23	27 1 59

Z HERCULIS 199 †
(continued).

March.	August.
d h m	d h m
7 1 38	5 19 1
15 1 18	13 18 40
23 0 57	21 18 19
31 0 36	29 17 58
April.	Sept.
8 0 15	6 17 37
15 23 54	14 17 17
23 23 33	22 16 56
	30 16 35
May.	Oct.
1 23 12	8 16 14
9 22 51	16 15 53
17 22 30	24 15 32
25 22 9	
June.	Nov.
2 21 48	1 15 11
10 21 27	9 14 50
18 21 7	17 14 29
26 20 46	25 14 8
July.	Dec.
4 20 25	3 13 47
12 20 4	11 13 27
20 19 43	19 13 6
28 19 22	27 12 45

W DELPHINI 247 †.

$$\left\{ \begin{array}{l} 1=4^d 19^h 21^m \\ 2=9 14 42 \end{array} \right\}$$

Jan.	May.
d h m	d h m
5 3 25	14 21 57
19 13 28	29 8 1
Feb.	June.
2 23 32	12 18 4
17 9 36	27 4 8
March.	July.
3 19 39	11 14 12
18 5 43	26 0 15
April.	Aug.
1 15 46	9 10 19
16 1 50	23 20 22
30 11 54	

W DELPHINI 247 †
(continued).

Sept.	Nov.
d h m	d h m
7 6 26	3 22 40
21 16 30	18 8 44
Oct.	Dec.
6 2 33	2 18 48
20 12 37	17 4 51
	31 14 55

Y CYGNI 262 †.

$$\left\{ \begin{array}{l} 1=1^d 1^h 32^m \\ 2=2 23 55 \\ 3=4 1 26 \end{array} \right\}$$

Jan.	June.
d h m	d h m
2 16 58	1 12 44
8 16 48	7 12 34
14 16 37	13 12 23
20 16 27	19 12 13
26 16 17	25 12 3
Feb.	July.
1 16 7	1 11 53
7 15 57	7 11 43
13 15 47	13 11 33
19 15 36	19 11 22
25 15 26	25 11 12
	31 11 2
March.	August.
3 15 16	6 10 52
9 15 6	12 10 42
15 14 56	18 10 32
21 14 46	24 10 21
27 14 36	30 10 11
April.	Sept.
2 14 25	5 10 1
8 14 15	11 9 51
14 14 5	17 9 41
20 13 55	23 9 31
26 13 45	29 9 21
May.	Oct.
2 13 35	5 9 10
8 13 24	11 9 0
14 13 14	17 8 50
20 13 4	23 8 40
26 12 54	29 8 30

† Every third minimum only.

‡ Every fourth minimum only.

Minima of Variable Stars of the Algol Type (continued).

Y CYGNI 262 ‡ (continued).		S ANTLIÆ 90 § (continued).		S ANTLIÆ 90 § (continued).	
Nov.	Dec.	March.	May.	July.	Oct.
d h m	d h m	d h m	d h m	d h m	d h m
4 8 20	4 7 29	19 22 50	20 13 2	21 3 14	26 9 14
10 8 9	10 7 19	23 4 38	23 18 50	24 9 2	29 15 2
16 7 59	16 7 8	26 10 26	27 0 38	27 14 50	
22 7 49	22 6 58	29 16 14	30 6 26		
28 7 39	28 6 48				
S ANTLIÆ 90 §.		April.	June.	Sept.	Nov.
Jan.	Feb.				
d h m	d h m				
1 3 38	9 1 14	1 22 2	2 12 14	4 12 26	1 20 50
4 9 26	12 7 2	5 3 50	5 18 2	7 18 14	5 2 38
7 15 14	15 12 50	8 9 38	8 23 50	11 0 2	8 8 26
10 21 2	18 18 38	11 15 26	12 5 38	14 5 50	11 14 14
14 2 50	22 0 26	14 21 14	15 11 26	17 11 38	14 20 2
17 8 38	25 6 14	18 3 2	18 17 14	20 17 26	18 1 50
20 14 26	28 12 2	21 8 50	21 23 2	23 23 14	21 7 38
23 20 14		24 14 38	25 4 50	27 5 2	24 13 26
27 2 2		27 20 26	28 10 38	30 10 50	27 19 14
30 7 50					
Feb.	March.	May.	July.	Oct.	Dec.
d h m	d h m				
2 13 38	3 17 50	1 2 14	1 16 26	3 16 38	1 1 2
5 19 26	6 23 38	4 8 2	4 22 14	6 22 26	4 6 50
	10 5 26	7 13 50	8 4 2	10 4 14	7 12 38
	13 11 14	10 19 38	11 9 50	13 10 2	10 18 26
	16 17 2	14 1 26	14 15 38	16 15 50	14 0 14
		17 7 14	17 21 26	19 21 38	17 6 2
				23 3 26	20 11 50
					23 17 38
					26 23 26
					30 5 14

‡ Every fourth minimum only.

§ Every tenth minimum only; the others may be found by adding multiples of the period $7^h 46^m.8$.

MAXIMA OF U PEGASI 293.

Jan.	April.	June.	August.	Oct.	Dec.
d h m	d h m	d h m	d h m	d h m	d h m
1 3 42	11 12 31	2 10 27	3 17 34	1 13 38	2 20 46
4 14 46	14 23 34	5 21 31	7 4 38	5 0 42	6 7 49
8 1 49	18 10 38	9 8 34	10 15 42	8 11 46	9 18 53
11 12 53	21 21 42	12 19 38	14 2 46	11 22 49	13 5 57
14 23 57	25 8 46	16 6 42	17 13 49	15 9 53	16 17 1
18 11 1	28 19 49	19 17 46	21 0 53	18 20 57	20 4 4
21 22 4		23 4 49	24 11 57	22 8 1	23 15 8
25 9 8		26 15 53	27 23 1	25 19 4	27 2 12
28 20 12		30 2 57	31 10 4	29 6 8	30 13 16
Feb.	May.	July.	Sept.	Nov.	
d h m	d h m	d h m	d h m	d h m	
1 7 16	2 6 53	3 14 1	3 21 8	1 17 12	
4 18 19	5 17 57	7 1 4	7 8 12	5 4 16	
8 5 23	9 5 1	10 12 8	10 19 16	8 15 19	
11 16 27	12 16 4	13 23 12	14 6 19	12 2 23	
15 3 31	16 3 8	17 10 16	17 17 23	15 13 27	
18 14 34	19 14 12	20 21 19	21 4 27	19 0 31	
22 1 38	23 1 6	24 8 23	24 15 31	22 11 34	
25 12 42	26 12 19	27 19 27	28 2 34	25 22 38	
28 23 46	29 23 23	31 6 31		29 9 42	

Every fifteenth maximum is given; the others may be found by adding multiples of the period $5^h 32^m 2^s$.The minimum takes place $2^h 28^m$ after the maximum.

MAXIMA AND MINIMA OF VARIABLE STARS.

The No. refers to Catalogue on pp. 24-26; M signifies maximum; m, minimum.

January.	February	March	May	June	August.	September	October	November
d No.	d No.	d No.	d No.	d No.	d No.	d No.	d No.	d No.
1 53 m	10 13 M	22 271 M	8 248 m	20 98 m	1 271 M	5 238 m	19 237 M	26 214 m
2 67 M	10 48 m	23 41 m	9 165 M	21 178 m	3 155 M	6 141 M	19 145 m	26 11 M
3 67 m	11 241 M	26 205 M	10 50 m	22 185 m	4 143 m	6 241 M	20 240 M	27 53 m
8 m	11 98 M	27 97 m	47 M	23 242 M	7 37 m	7 128 M	20 117 M	27 152 m
273 m	13 46 M	31 m	168 M	108 m	127 M	95 M	42 M	248 M
4 288 M	13 186 M	14 m	12 258 M	64 m	5 38 M	187 M	21 41 M	29 113 M
249 m	15 229 M	27 262 M	14 270 m	133 m	6 191 M	256 M	28 M	30 245 M
1 M	15 152 M	29 164 M	58 m	69 M	7 20 m	9 62 M	43 m	133 m
230 m	16 256 M	28 51 M	15 264 M	24 102 m	7 272 M	169 M	50 m	
214 m	17 50 M	140 m	98 m	157 m	8 98 M	12 98 M	22 31 m	
6 216 M	18 67 m	242 m	16 291 m	25 244 M	8 19 M	84 M	218 M	
98 M	190 M	29 148 m	17 175 M	27 86 M	4 m	157 M	236 M	
7 132 M	19 11 M	66 M	131 M	29 16 m	10 26 m	13 94 M	23 180 M	1 266 m
8 280 M	277 M	30 59 m	19 152 m	30 72 m	11 193 m	14 243 M	24 142 M	2 40 M
10 295 M	138 M	31 219 M	20 259 m	112 M	11 168 M	15 158 M	25 35 M	7 n
11 126 m	107 M	286 M	231 M	31 M	12 249 M	14 m	25 100 M	4 288 M
157 m	20 214 m	282 m	279 M		12 77 m	163 M	26 242 m	5 157 n
271 m	21 158 M		230 m		106 m	67 M	26 128 m	5 178 M
13 133 M	22 269 m	April.	21 67 m	July.	96 M	16 149 M	27 1 M	6 270 n
14 72 M	248 M	22 81 M	22 81 M	2 273 M	15 129 M	17 214 M	28 230 M	7 223 M
15 113 M	23 96 m	1 157 M	23 271 m	3 24 M	16 259 M	18 22 M	30 239 M	7 128 M
4 M	24 19 m	3 120 M	118 m	98 M	6 M	188 m	31 220 M	229 n
16 7 m	15 m	4 22 M	24 214 m	4 117 m	242 m	19 46 M	162 m	14 M
17 242 m	25 32 M	5 67 m	25 250 m	5 275 M	17 73 M	20 15 M		8 230 n
21 65 M	26 52 m	7 174 M	26 240 M	15 M	97 M	20 285 M		10 259 n
27 37 M	6 m	8 253 M	28 43 M	6 225 m	18 9 m	21 250 M	November.	12 271 M
22 225 m	28 36 M	9 214 m	28 98 M	9 67 m	19 223 m	21 58 M	1 67 M	13 19 n
266 M		9 95 m	29 100 M	9 172 m	20 85 M	22 71 m	2 214 M	13 292 M
23 245 M	March.	230 M	27 m	9 63 m	20 59 M	22 254 m	4 72 M	13 160 M
24 259 M	1 116 M	13 98 m	229 m	10 214 m	21 66 m	24 248 m	5 32 M	14 264 n
2 22 m	3 24 m	13 64 M	30 53 M	11 22 m	21 265 M	26 99 M	5 49 M	14 168 n
25 128 m	4 100 m	14 8 M	31 109 M	11 224 M	21 171 M	27 45 M	6 207 M	15 98 n
26 244 m	5 58 m	15 254 M		12 248 M	22 288 m	28 263 M	7 244 m	15 26 M
27 17 M	5 54 M	16 188 M	June.	13 148 M	22 67 m	28 257 M	8 244 m	15 47 n
237 M	12 M	17 163 m	1 61 M	13 116 m	13 137 M	29 246 m	8 154 m	15 195 M
28 214 M	8 67 M	18 137 m	200 M	14 161 M	230 M	9 98 M	9 98 M	15 222 M
43 m	118 M	19 288 M	141 m	14 124 M	68 M	10 108 M	9 175 M	15 77 M
98 m	128 M	20 255 M	177 M	14 142 m	294 m	10 108 M	10 108 M	15 106 M
29 246 M	154 M	223 M	6 268 m	18 121 m	24 78 m	1 271 m	16 64 m	16 255 M
30 156 M	11 68 m	287 m	35 m	19 110 M	24 170 M	2 230 m	130 m	16 156 M
71 M	168 m	21 290 m	7 202 M	20 281 M	25 225 M	3 234 M	132 M	18 9 M
31 61 m	12 266 M	23 67 M	106 M	21 269 M	25 214 m	4 176 M	242 M	18 5 M
230 M	144 M	23 98 M	242 m	22 120 m	26 266 M	4 120 M	2 M	225 m
	88 M	24 172 M	76 M	22 3 M	229 M	6 98 m	120 m	190 M
February.	13 142 M	25 39 M	128 M	23 39 m	26 270 M	6 116 M	168 M	67 M
1 270 M	225 M	26 145 m	9 289 m	23 186 m	27 152 M	8 m	13 51 m	214 M
2 106 M	230 m	27 128 m	10 7 M	24 222 m	28 228 M	177 m	15 280 M	20 186 M
20 m	14 260 m	29 5 M	11 241 m	25 98 m	30 98 m	67 m	16 63 M	48 m
242 M	133 M	30 162 M	12 153 M	26 54 M	31 64 M	21 M	17 2 M	131 M
39 m	15 78 M	30 91 m	12 168 m	26 140 M	18 M	9 102 M	174 M	22 291 M
3 145 M	240 m	266 m	13 2 m	27 230 m	202 m	8 287 M	202 M	23 118 M
171 M	220 m	214 M	67 M	27 128 m		10 214 m	18 269 m	23 268 M
64 m	214 M	24 172 M	14 125 M	28 48 M		12 185 M	19 277 M	24 87 m
4 129 m	16 18 m	May.	15 230 M	29 264 m	September.	13 39 M	19 282 m	24 22 m
5 26 M	17 265 M	1 160 M	16 214 M	30 190 m	1 242 M	14 121 M	21 67 m	25 118 M
143 M	18 98 M	2 183 m	21 m	30 145 M	2 260 M	15 118 m	22 148 m	26 295 M
9 M	19 222 M	3 40 m	17 126 M	30 67 M	3 13 m	16 52 m	23 98 M	26 100 m
168 M	234 M	4 20 M	18 181 M	30 100 m	4 227 m	17 209 m	23 216 M	27 140 m
117 M	44 M	6 49 m	14 M	30 118 M	3 221 M	17 290 M	25 232 m	28 98 n
8 185 M	238 M	7 109 M	19 278 M	30 107 M	4 239 M	18 98 M	25 276 M	28 133
9 179 M	21 121 M	7 243 M	150 m	30 50 M	4 183 M	18 30 M	16 M	

DOUBLE STARS.

No.	Star's name.	R.A. 1900.	Dec. 1900.	Mag.	Pos.- angle.	Dis- tance.	Epoch. 1890+.	Ob- server
		h m	° ' "			"		
1.	Σ 3062	0 0'9	+57 52	6½; 7½	336.6	1'66	7'17	D.
2.	Σ 13	0 10'3	+76 24	6½; 7	87.7	0'92	5'90	O.
3.	$\text{O}\Sigma$ 12, λ Cassiop.	0 26'4	+53 58	6½; 6½	148.6	0'58	4'03	B.
4.	$\text{O}\Sigma$ 18	0 37'2	+3 36	7½; 9½	127.2	1'47	4'83	B.
5.	β 866	0 39'1	+42 34	9; 9	69.6	1'39	1'83	β .
6.	Σ 60, η Cassiop.	0 43'0	+57 17	3½; 7½	209.3	4'74	7'27	D.
7.	$\text{O}\Sigma$ 20, 66 Piscium ...	0 49'2	+18 29	6; 6	335.0	0'32	5'90	La.
8.	Σ 73, 36 Andromedæ ...	0 50'1	+23 2	6; 6½	11.2	1'18	5'90	La.
9.	Σ 113, 42 Ceti	1 14'3	-1 3	6½; 7	349.7	1'68	4'88	La.
10.	Σ 138	1 30'8	+7 7	7; 7½	37.5	1'51	5'92	La.
11.	p Eridani	1 35'7	-56 0	6; 6	224.0	7'35	4'96	S.
12.	β 509	1 38'2	+8 53	8; 8½	257.5	0'74	5'91	La.
13.	Σ 202, α Piscium	1 56'8	+2 17	4; 5	320.2	2'78	5'85	C.
14.	Σ 205, γ Androm. AB.	1 57'8	+41 51	2½; 5½	63.2	10'33	5'88	La.
15.	Σ 228	2 7'3	+56 59	6½; 7½	66.9	0'27	6'09	La.
16.	Σ 305	2 41'8	+18 58	7½; 8	315.9	2'90	6'08	La.
17.	Σ 333, ϵ Arietis	2 53'5	+20 56	5½; 6	202.1	1'34	6'08	La.
18.	$\text{O}\Sigma$ 50	3 1'5	+71 4	7; 7	205.9	1'27	3'21	M.
19.	β 530	3 9'1	+22 33	9½; 10	182.7	1'68	0'10	La.
20.	Σ 412, 7 Tauri	3 28'5	+24 8	6½; 7	204.5	0'30	6'08	La.
21.	Σ 422	3 31'8	+0 16	6; 8	927.1	6'19	5'90	C.
22.	Σ 425	3 33'8	+23 42	7½; 8	247.7	3'00	4'19	M.
23.	Σ 460	3 53'2	+80 25	6; 7	43.8	0'96	3'21	M.
24.	$\text{O}\Sigma$ 531	4 0'5	+37 48	7; 7½	127.3	2'45	5'88	La.
25.	Σ 518, ϕ^3 Eridani	4 10'6	-7 49	8½; 10½	87.4	2'32	5'91	O.
26.	$\text{O}\Sigma$ 79, 55 Tauri	4 14'2	+16 17	6½; 8	87.9	0'38	0'67	β .
27.	Σ 555	4 17'7	+11 9	7; 8	330.5	2'07	5'06	La.
28.	Σ 572	4 32'2	+26 44	6; 6	202.1	3'69	4'13	M.
29.	$\text{O}\Sigma$ 98, i Orionis	5 2'4	+8 22	5½; 7	181.7	1'01	6'02	M.
30.	Σ 742, 380 Tauri	5 30'4	+21 56	7; 7½	258.8	3'50	5'16	M.
31.	Σ 749	5 30'9	+26 53	6½; 7½	177.6	0'74	7'08	La.
32.	Σ 932	6 28'5	+14 49	8; 8	328.1	2'34	3'18	La.
33.	Σ 945	6 33'3	+41 4	7; 8	269.0	0'54	3'24	La.
34.	Σ 948, 12 Lynceis AB.	6 37'3	+59 33	6; 6½	120.2	1'80	6'07	O.
35.	Sirius	6 40'6	-16 34	1; 10	175.9	3'92	7'73	Ait.
36.	Σ 982, 38 Geminor. ...	6 49'0	+13 18	5½; 8	160.7	6'77	3'21	La.
37.	Σ 1037	7 6'6	+27 24	7; 7	307.0	1'01	6'08	O.
38.	$\text{O}\Sigma$ 170	7 12'2	+9 29	7; 7½	112.4	0'74	3'15	La.
39.	Σ 1066, δ Geminor. ...	7 14'1	+22 10	3; 8	205.3	6'89	6'08	C.
40.	Σ 1074	7 15'4	+0 36	7½; 8½	133.8	0'68	6'18	La.
41.	$\text{O}\Sigma$ 175	7 27'7	+31 10	6; 6½	324.2	1'02	6'08	La.
42.	Σ 1110, Castor	7 28'2	+32 7	2; 3	228.1	5'96	7'14	La.
43.	Procyon	7 34'0	+5 29	1; 8½	324.1	4'70	7'77	Sch.
44.	Σ 1187	8 3'2	+32 31	7; 8	46.0	2'17	6'15	La.
45.	Σ 1196, ζ Canceri AB.	8 6'4	+17 59	5½; 7½	18.1	1'03	6'18	La.
46.	" " AC .....	.....	.....	5½; 6½	116.3	5'22	6'18	La.
47.	" " BC .....	.....	.....	7½; 6½	128.9	5'50	6'18	La.
48.	β 205	8 28'8	-24 16	7; 7	252.6	0'3	3'20	S.
49.	Σ 1263	8 38'6	+42 4	7½; 8	20.6	51'42	5'30	La.
50.	Σ 1273, ϵ Hydræ	8 41'5	+6 50	4; 7	231.4	3'68	5'23	La.
51.	Σ 1312	9 11'9	+29 0	7½; 7½	196.1	0'70	7'31	La.
52.	Σ 1348	9 19'2	+6 50	7½; 7½	322.0	1'77	6'20	La.
53.	$\text{O}\Sigma$ 201	9 18'0	+28 20	7; 11	222.4	1'24	7'31	La.
54.	Σ 1356, ω Leonis	9 23'1	+9 30	5½; 7	107.5	0'84	7'16	La.
55.	Σ 1389	9 45'3	+27 29	8; 9	309.5	2'48	6'20	La.
56.	Σ 1417	10 9'5	+19 40	8½; 8½	257.7	2'56	2'29	M.
57.	$\text{O}\Sigma$ 215, P. x. 23	10 10'9	+18 15	6½; 7	207.2	0'77	7'32	La.
58.	Σ 1424, γ Leonis	10 14'4	+20 22	2; 4	115.6	3'63	6'31	La.
59.	$\text{O}\Sigma$ 218	10 22'1	+4 5	7; 9	74.0	1'04	6'30	La.
60.	$\text{O}\Sigma$ 224	10 34'5	+9 22	7; 9	317.4	0'58	7'34	La.

DOUBLE STARS (continued).

No.	Star's name.	R.A. 1900.	Dec. 1900.	Mag.	Pos.- angle.	Dis- tance.	Epoch 1890+.	Ob- server.
		h m	°		°	"		
61.	OE 229	10 42.3	+41 38	6 ; 7	317.7	0.93	7.23	La.
62.	Σ 1523, ξ Ursæ Maj.	11 12.9	+32 6	4 ; 5	163.8	1.94	7.31	La.
63.	Σ 1536, ι Leonis	11 18.7	+11 5	4½ ; 7½	59.6	2.53	6.34	La.
64.	OE 235	11 26.7	+61 38	5½ ; 7	98.1	0.91	7.38	D.
65.	Σ 1606	12 5.7	+40 27	6 ; 7	330.2	1.10	5.57	M.
66.	Σ 1647, 191 Virginis.....	12 25.5	+10 16	7½ ; 8	224.4	1.00	7.34	La.
67.	Σ 1670, γ Virginis ...	12 36.7	- 0 54	3 ; 3	153.2	5.96	6.36	La.
68.	Σ 1687, 35 Comæ	12 48.1	+21 48	5 ; 8	71.6	1.06	7.34	La.
69.	β 112	12 55.2	+19 1	9 ; 9½	292.0	2.24	6.41	La.
70.	OE 266	13 23.6	+16 14	7 ; 8	339.1	1.70	6.41	La.
71.	Σ 1757, P. xiii. 127 ..	13 29.3	+ 0 12	7½ ; 8	80.0	2.62	3.42	La.
72.	Σ 1768, 25 Can. Ven. ...	13 33.2	+36 48	6 ; 8	138.8	1.41	7.45	D.
73.	Σ 1785	13 44.5	+27 29	7½ ; 8	263.2	1.44	6.38	La.
74.	Σ 1788	13 49.7	- 7 34	6½ ; 7½	75.5	2.60	6.38	M.
75.	Σ 1819	14 10.3	+ 3 36	7½ ; 7½	182.9	1.30	7.32	La.
76.	Σ 1865, ζ Boötis	14 36.3	+14 10	4 ; 4	273.2	0.20	6.38	La.
77.	Σ 1877, ε Boötis	14 40.6	+27 30	3 ; 6½	326.1	2.70	6.46	M.
78.	Σ 1879	14 41.3	+10 4	8 ; 8½	138.4	0.43	7.36	D.
79.	Σ 1888, ξ Boötis	14 46.7	+19 31	5 ; 7	216.3	2.85	7.38	D.
80.	β 31	14 47.8	+19 9	8½ ; 9½	194.4	1.36	7.44	La.
81.	OE 287	14 47.9	+45 20	7 ; 8	316.3	0.85	6.68	M.
82.	β 119	15 0.0	- 6 36	8 ; 8½	307.1	1.47	2.35	L.
83.	β 350	15 8.2	-27 10	7 ; 8½	160.2	1.15	2.41	L.
84.	Σ 1932, ι Cor. Bor.	15 14.0	+27 13	6½ ; 7	325.3	0.77	7.37	La.
85.	Σ 1937, η Cor. Bor.	15 19.1	+30 40	6 ; 6	320.1	0.40	7.34	La.
86.	Σ 1938, μ² Boötis	15 20.7	+37 22	6½ ; 7½	82.2	0.92	6.56	M.
87.	OE 298	15 32.4	+40 8	7 ; 7½	180.1	1.23	7.59	D.
88.	Σ 1967, γ Cor. Bor.	15 38.5	+26 36	4 ; 7	121.5	0.40	7.38	La.
89.	OE 303	15 56.2	+13 33	7 ; 7½	141.6	0.67	7.43	La.
90.	Σ 1998, ξ Scorpil	15 58.8	-11 5	5 ; 5½	215.3	0.94	6.46	M.
91.	Σ 2032, σ Coronæ	16 11.1	+34 7	6 ; 6½	210.6	4.16	6.45	La.
92.	Σ 2055, λ Ophiuchi ...	16 25.8	+ 2 12	4½ ; 5½	47.0	1.40	6.44	La.
93.	Σ 2084, ζ Herculis	16 37.5	+31 47	3 ; 6½	6.0	0.53	6.44	La.
94.	Σ 2107, 167 Herculis ...	16 47.8	+28 50	7 ; 8½	288.4	0.39	7.45	La.
95.	Σ 2140, α Herculis ...	17 10.1	+14 30	2½ ; 6	115.8	4.93	6.52	La.
96.	Σ 2173, 221 Ophiuchi ...	17 25.5	- 0 59	6 ; 6	336.4	0.97	6.54	La.
97.	OE 338	17 47.4	+15 21	6½ ; 6½	14.4	0.72	6.50	La.
98.	Σ 2262, τ Ophiuchi ...	17 57.6	- 8 11	5 ; 6	253.9	1.84	3.47	M.
99.	Σ 2272, 70 Ophiuchi ...	18 0.4	+ 2 32	4 ; 6	290.2	2.08	6.62	La.
100.	OE 358	18 31.3	+16 54	6½ ; 7	195.3	1.98	6.50	La.
101.	β 648	18 54.2	+23 39	6 ; 9	231.2	1.16	7.44	La.
102.	γ Coronæ Aust.	19 0.0	-37 12	5½ ; 5½	164.0	1.03	4.71	S.
103.	β 248	19 13.4	+22 51	6 ; 9	125.4	1.86	0.63	β.
104.	Σ 2579, δ Cygni	19 41.8	+44 53	3 ; 8	303.8	1.75	6.80	M.
105.	Σ 2695	20 27.7	+25 28	6 ; 8	77.7	0.93	7.53	La.
106.	β 151, β Delphini ...	20 32.7	+14 15	3½ ; 5½	338.7	0.20	5.81	La.
107.	Σ 2729	20 46.3	- 5 59	6½ ; 6½	191.8	0.20	5.81	La.
108.	Σ 2799	21 23.9	+10 38	7 ; 7½	119.4	1.22	5.72	La.
109.	Σ 2822, μ Cygni	21 39.7	+28 18	4 ; 5	123.2	2.91	5.75	La.
110.	Σ 2909, ζ Aquarii	22 23.7	- 0 32	4 ; 4	322.7	3.31	6.86	M.
111.	Σ 2944, AB	22 42.7	- 4 45	7 ; 7½	255.5	3.50	2.76	M.
112.	OE 483, 52 Pegasi	22 54.2	+11 12	6 ; 7½	216.9	1.10	1.29	M.
113.	β 79	23 11.8	- 2 9	8 ; 8½	94.6	0.88	1.54	β.
114.	β 80	23 13.2	+ 4 53	8 ; 8½	325.1	0.64	4.85	La.
115.	OE 547	0 0.4	+45 16	8 ; 8	340.8	4.30	1.73	H.

In the column headed "Observer," the following abbreviations are used:—

L. Leavenworth.	β. Burnham.	M. Maw.	S. Sellors.
La. Lewis.	B. Bijourdan.	H. Hall.	O. Collins.
Sch. Schaeberle.	D. Doolittle.	Ait. Aitken.	

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

JANUARY, 1898.

No. 262.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, December 10, 1897.

Sir R. S. BALL, LL.D., F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. TURNER, M.A., B.Sc., F.R.S., and
F. W. DYSON, M.A.

THE Minutes of the previous Meeting were read and confirmed.

The President. Owing to circumstances known to Fellows present we are to lose temporarily the services of our two Secretaries. Mr. Newall has already started; Professor Turner is about to start immediately for India to observe the eclipse, and, as the Society could not be left in a helpless condition during the absence of both Secretaries, we have appointed two substitutes and given them full powers to act in the absence of Professor Turner and Mr. Newall. The Council have to-day chosen Mr. Knobel and Mr. Dyson to act as Secretaries until their return.

Mr. Dyson. Eighty presents have been received since the last Meeting. One of these, a $3\frac{1}{4}$ equatorial by Ross, with tripod stand, is presented by Mrs. Mann. The other presents consist of papers and periodicals. Those which perhaps call for special notice are, first, a memoir by Dr. Johnstone Stoney on 'Atmospheres upon Planets and Satellites.' A volume from Bonn which contains a determination by Dr. Küstner of the proper motions of 335 stars from comparison with older observations of his own; these are redeterminations of the proper motions of stars first determined by Argelander. Then we have some photographs of nebulae taken with a 24-inch reflector by Mr. W. E. Wilson, of Daramona, of which lantern-slides have been sent to the Society. Mr. W. F. Denning has sent us his pamphlet on the Great Meteoric Shower of November, and photographs have been received from the Lick Observatory of Sheets 6 to 19 of the Atlas of the Moon which is being made there.

The President. The telescope is a noteworthy addition to the instruments which we have here. Among the donations announced by the Secretary you will have noticed that some slides have been given by Mr. Wilson, who has already been so successful at Daramona in Ireland; these will be shown on the screen, and for comparison we will show some slides which have been taken by Dr. Isaac Roberts.

Mr. Wesley then described the photographs referred to as they were exhibited on the screen. These consisted of the Nebulæ in Orion taken with 40 minutes' exposure with the 24-inch reflector by Mr. W. E. Wilson, which, Mr. Wesley said, showed a good deal of external detail. He thought that this was one of the most successful photographs of the Nebula in Orion. The next picture was of the same nebula taken by Dr. Roberts with 80 minutes exposure, but the detail, although extremely beautiful in the centre, did not show the furthest extension. The next photograph by Dr. Roberts had been taken with an exposure of $5\frac{1}{2}$ hours and showed the exterior nebulosity a little more strongly than Mr. Wilson's photograph, but the interior was overexposed. The next photograph was by Mr. Wilson, and showed the Ring Nebula in Lyra taken with 20 minutes' exposure. Mr. Wesley called attention to the absence of granulation on this plate, and at the same time to the great clearness of the ring. The lessening of the light at the end of the ring was extremely obvious. Dr. Roberts's photograph of the same object was made with an exposure of one hour. The next picture was of the nebula in Canes Venatici with an exposure of 90 minutes. There was a slight elongation of the stars, but the nebula was extremely fine and the manner in which the stars were arranged along the spiral was very distinct. An enlargement of this photograph was next shown, and Mr. Wesley called attention to the point that from some of those stars there appeared markings like little comets' tails running out from them tangentially. The next slide was a picture of the same object by Dr. Roberts with four hours' exposure, and showed the same comets' tails. The last slide was a photograph by Mr. Wilson of the Dumb-bell Nebula on a small scale, but very clear, and was taken with 20 minutes' exposure. Dr. Roberts's photograph of this was made with an exposure of three hours.

The President. There can be but one feeling among Fellows, and that is that Mr. Wilson's photographs are of rare and exceptional beauty. We have had great pleasure in seeing them to-night, and wish him every success in his career of photographing the heavens.

Capt. W. Noble. There has never been a more beautiful astronomical photograph than that we have seen on the screen of Mr. Wilson's Nebula in Orion. It is perfectly exquisite.

Mr. Gregory. I should like to ask what plates Mr. Wilson used, because since Dr. Roberts took his photographs several years

have elapsed and improvements have been made in the rapidity of the plates, which might account for the shorter exposure that Mr. Wilson found as necessary compared with Dr. Roberts.

Mr. Wesley. I am not certain, but I think Mr. Wilson said he used Cadett plates.

Prof. Turner. It occurs to me to say what a valuable officer a Permanent Secretary is to this Society. Mr. Wesley being always on the spot when presents of this kind are sent, it naturally suggests itself to him that there are other photographs for comparison in possession of the Society, which is a thing we temporary Secretaries may not think of. I am sure the Meeting knows quite well why the two series were put upon the screen together. It was not to make invidious comparison between the skill of one man and the skill of another. There has been an improvement in plates, and it is important to see the definite advances astronomical photography is making year after year, which are measured by the lessening of exposure by a few minutes, and it is a great gain to us to have a man like Mr. Wesley watching these advances and able to indicate it in the way he has just done. Later in the evening I hope we shall have another series of photographs shown by Mr. Wesley, with his remarks thereon—the series of pictures of the corona which the Photographic Committee has made. Mr. Wesley some ten years ago laid before the Society some of the facts which he had gathered about the corona; he has now a longer series built upon the same lines, and I know we shall have much pleasure in seeing them.

Mr. McCarthy. With regard to the Nebula in Orion, I should like to express the hope that any Fellow present who is acquainted with any change which has taken place in Orion will mention it. I have looked through what has been observed, and I have never discovered from the photographs the least trace of change which has taken place, and also, so far as drawings can be relied upon, there seems to have been no change whatever.

Dr. Rambaut then read a short account of the observation at Oxford of the recent Occultation of Ceres by the Moon. He also gave an account of the observation of the Leonid Meteors at the Radcliffe Observatory on November 13th. The watch for meteors was kept up continuously by Mr. Wickham and Mr. Robinson from 11^h 15^m to 17^h 45^m Greenwich Mean Time, when the clouds prevented any further observation. The night was fine, the atmosphere was clear, but there were occasional clouds, and the moonlight was somewhat troublesome, the Moon being situated not far from Leo. During the whole watch of 6½ hours only about 40 meteors were seen. Generally speaking they were very swift, and some of them too fast to leave a very definite impression of their path, so their tracks could not be put down. The night of the 14th was overcast, with rain at intervals, but on the 15th Mr. Robinson reported that frequent breaks occurred in the

neighbourhood of Leo between $12^h 20^m$ and $12^h 30^m$, during which time only one meteor was seen. He concluded that though the sky was obscured the greater part of the time, there could not have been anything like a very splendid display.

Mr. Dyson then read a paper, communicated by the *Astronomer Royal*, "On the Proper Motion of three Polar Stars." These three stars were now included in the Greenwich clock-star list for computation of azimuth error.

Mr. W. E. Plummer. What value for the precession constant is now used at Greenwich?

Mr. Dyson. Struve-Peters.

Mr. Plummer. Does that answer imply that Prof. Newcomb's recent determination will not be adopted at present?

Mr. Dyson. I know of no proposal to introduce any change.

Prof. Turner then read a paper by *Mr. W. H. Finlay* "On a Determination of the Latitude Variation and of the Constant of Aberration from Observations made at the Royal Observatory, Cape of Good Hope, 1892-94." It was, Prof. Turner said, a paper of a technical character, but the interesting part of it was the result for the constant of aberration as obtained by Mr. Finlay. He got a rather large correction to the old adopted value, and his final constant of aberration was

$$20''.57 \pm 0''.01.$$

The proposal of the Paris Conference was to adopt $20''.47$, so they were not yet at the end of the story about aberration.

There was then thrown on the screen a photograph from *Prof. Barnard* illustrating the fall of the movable floor of the Yerkes Observatory.

The President. This is interesting as showing that the course of building great telescopes does not always run smoothly.

Mr. Maw then exhibited some slides which had been made by the Photographic Committee.

The President. We are very glad to have seen this series of slides, and I only hope Mr. Maw may be able to add to it the beautiful pictures made by Mr. Wilson. So long as we know that there are good photographs of the heavens which are not in our series, we shall always feel that they ought to be.

Mr. Wesley then showed on the screen a series of photographs of the corona which had been reproduced by the Photographic Committee on the initiative of Capt. Hills. The great advantage of this series is that it is now possible for the first time to compare actual photographs of almost all the Solar Eclipses that have ever been photographed. Capt. Hills had had them all reduced or enlarged to the same scale. The pictures showed the great superiority of the collodion plate for enlargement. The eclipse of 1870 was one of the first in which the corona was photographed, but the only good picture taken was taken by Brothers at Syracuse, and although it was good as a positive it was less so as a negative: this

is not included in the series. One advantage of having a series of this kind is that comparison can easily be made of the shape of the corona at different epochs of the sun-spot period. A sun-spot maximum occurred in 1870, and on the photograph taken in 1871 it was to be noted that the axis of the symmetry of the corona lay 10° to the west of the Sun's north pole. The reason for the continual change in the position of the axis of symmetry was very mysterious indeed. In the picture taken in 1875 in Siam the axis of symmetry apparently coincided roughly with the polar axis. That taken in 1878, though on a collodion plate, was one of the least satisfactory of the series, and on it the axis of symmetry seems to be inclined towards the east. In the corona of 1882 there was an entire absence of any axis of symmetry, but the corona was one of the largest extent. The photograph was taken by Dr. Schuster. In 1883 the axis of symmetry of the corona seemed very remarkably inclined towards the east. This was the eclipse observed at the Caroline Islands. The one taken in 1885 in New Zealand was the one that ought to be most similar to that of 1896, remembering the state of the sun-spot period. The only photograph to which we have access was taken by some people in New Zealand who were not well equipped, and there was no means of orienting the photograph with certainty. In 1886 the axis of symmetry was pretty fairly accordant with the solar axis. The photograph of 1887 was taken under great difficulty: this was the eclipse that failed. Photographs were then shown taken in January 1889, December 1889, in 1893, and in 1896, and Mr. Wesley pointed out that what was now looked upon as an established theory, namely that the corona varied with the sun-spots, was not so obvious from these photographs as was generally supposed. He was prepared for any surprise in the eclipse of next month, and he did not intend to put on the screen a "prophetic corona," as he believed in the good maxim "never prophecy unless you know."

Sir Robert Ball here left the Chair, which was occupied by *Mr. Knobel* for the rest of the evening.

Captain Steele. In papers in possession of the Society I have endeavoured to show that the Sun does not possess either light or heat, and that the Sun is an opaque body. Now the eclipse which is to take place next month and those which have taken place hitherto, confirm me more than anything else in my idea that the Sun is an opaque body. The encroachment of the Moon upon the Sun blinks the sunlight. If the Sun was the all-giver of light and heat that light should not be obscured. The Sun appears very little more to us in diameter than the Moon, but the Moon blinks the Sun to the observer, but not to those at a distance from the observer. The Moon's diameter appears equal to that of the Sun, or nearly so; it covers the Sun in the line of sight of the observer, but the Earth being larger than the Moon, a portion of the Earth's atmosphere passes the Moon, and striking the edge of the Sun

that extends beyond the Moon, produces the corona. The Sun is dependent upon the illumination of our atmosphere for its brilliancy. It appears to be a hard saying, and probably I have stood as much in the heat of the Sun as most men, yet I consider that the Sun's brilliancy to us is produced by the Earth's atmosphere striking the Sun's ray and giving light and brilliancy wherever the two meet. As Mr. Wesley has said, during the times of the sun-spots the corona appears to be extended more than at other times. The sun-spot is an atmospheric phenomenon, and it vivifies the effect of the atmosphere surrounding it, and it is from that that it illuminates to a greater extent the corona.

Mr. Gregory. I am sure that I am expressing the opinion of all the Fellows of the Society as well as my own, when I say how much we are indebted to the Photographic Committee for this splendid series of corona pictures. Only those who have attempted to reduce photographs to a uniform scale know how difficult it is to do this properly, and I personally am extremely indebted to the Committee for making these photographs available. I should like to ask Mr. Wesley whether he has not noticed in the cases of the coronas of 1878 and 1889 there is a close similarity of coronal type, and this seems to give very distinct evidence of a connection between the sun-spot period and the form of the corona. This is very distinctly shown in the drawings of the two phenomena. I have compared a drawing of 1878 with one of 1889 and with the photographs, and there is much more extension of the corona in the sun-spot zone than the photographs show.

Mr. Newbegin. I think one can but say that this is a most beautiful series of photographs. I have looked at the whole series, and all, save the last, are beautifully clear and sharp. I should like to ask Mr. Wesley if there is anything in the last plate peculiarly different to the rest: I have been looking at the screen through an opera-glass, but could not get a good focus of the Moon's limb on the last slide.

Mr. Wesley. I cannot enter into any theories of what the corona is. I have nothing to do with theories. In the reproductions just shown, the Moon, which is always encroached upon by radiation, was carefully stopped out to make it sharp. The last photograph was not one of the series, and in this the Moon's limb is not artificial, which explains Mr. Newbegin's difficulty.

Mr. Maw. I think it will be interesting to Fellows to know that Capt. Hills did the whole of the work on these photographs that you have seen to-night.

The Chairman. In presenting the thanks of the Society to Mr. Wesley for the very interesting communication he has made, and also to Capt. Hills, I may say it seems to me that the series might be supplemented by another one on the same scale of photographs of drawings prepared from original negatives. There is so much loss of detail in photographs produced by this method that I think if they were supplemented by the drawings made by Mr. Wesley it would add much to the interest of the series.

The Chairman. We have with us this evening one of our Fellows who has just returned from South Africa, where he has been to inaugurate and establish the gift made by him to the Cape Observatory. I am sure you will welcome Mr. McClean. Perhaps he will tell us about the erection and establishment of the instrument he has nobly given to the Cape Observatory, and we should like him to supplement it by some account of his own work on spectra.

Mr. McClean. I thank the Meeting for their kind welcome on my return from the Cape of Good Hope. I am sorry to say the telescope is not there yet. The observatory and rising-floor are complete, and I hope it will not be long before the telescope is there. I have had the pleasure of being at the Cape Observatory during the past six months and have experienced great kindness from Dr. and Mrs. Gill. I have learnt much from seeing the internal working of a big observatory, and I have also had an opportunity of continuing my own work of observing and photographing the spectra of stars. I have obtained photographs of the spectra of 120 stars—in fact, all in the southern heavens down to mag. $3\frac{1}{2}$. The spectra are enlarged, but are not yet fully compared or discussed. The instrument I used was the Cape Astrophotographic telescope, which has an aperture of 13 inches and a focal length of 135 inches, with my own prism mounted in front of the object-glass. I pass round for inspection the photographs of the spectra of a few typical southern stars, viz., μ Centauri, a helium star resembling γ Cassiopeia; α Argus, a beautiful example of the type of Procyon; α Centauri, of the solar type; and γ Crucis, of the same type as α Herculis. Also a photograph of the bright line spectrum of γ Argus, the only bright star of the Wolf-Rayet type.

Prof. Turner. I do not know whether Fellows realize that this is the completion of a survey of the whole heavens. Mr. McClean first went through the northern hemisphere at his observatory at Tunbridge Wells, and then took the opportunity offered by an invitation from Dr. Gill to complete the survey of the southern hemisphere. Apart from the work done by the Harvard astronomers, in which case the whole survey is the combined work of several men, I think that the only parallel to this work of Mr. McClean is that of the younger Herschel, who, it will be remembered, completed his survey of the nebulae of the northern hemisphere by his work at the Cape of Good Hope.

The Chairman. We are on the eve of parting with two of our most distinguished Fellows for a short time—they are going to India to observe the eclipse, and I am sure I express the sentiments of all present in desiring that they may have that full success which they wish for in India. Prof. Turner and the Astronomer Royal are going out for this purpose, and we hope that their journey will be attended with every possible success.

The Astronomer Royal. It is a great satisfaction and encourage-

ment to us to go out with the good wishes of the Astronomical Society. As regards my arrangements, I am simply hoping to repeat in India the programme which I failed to carry out in Japan. I am taking out the same instruments—a 9-inch photographic object-glass, with enlarging arrangements which will give an image of the Sun four inches in diameter on 12- by 10-inch plates. If the sky favours us, I hope to get photographs of the corona on a large scale to show the detail of the inner corona, which there has been a difficulty in getting on small scale photographs. That is an important work which it is necessary to do, and which I have the means of doing through the generosity of Sir Henry Thompson, who some years ago presented the 9-inch telescope to the Observatory. Thanks to the invention of the coelostat, we are able to use a long-focus telescope without having to take out large equatorial mountings, which would have involved some difficulty. There are only two alterations in the Japan programme. The perfecting of the dry collodion plates which has been effected lately will, I hope, give us the opportunity of obtaining photographs free from that coarseness of grain which seems to be inseparable from gelatine plates. There is a sacrifice of sensitiveness in these plates, but for getting details of the inner corona we have abundance of light; therefore I propose to take at least three of these plates. The results we have lately obtained at Greenwich have been very promising. That is one direction in which I am working. I have another scheme on hand by which I hope to secure results of quite a different character. I shall try to determine, by means of photographs taken during the partial eclipse, the relative position of the Sun and Moon, which is an important point in practical astronomy. This involves certain data. We require an exact determination of local time and the longitude of the station, and arrangements will be made by the Ordnance Survey Department in India, acting with the consent of the Government of India, to enable us to have accurate determination of time and of the longitude of our station. This, however, I look upon as a subsidiary matter, which I hope to carry out, but that depends rather upon circumstances. The main object with which I am going out is to obtain photographs of the corona on a large scale which will show specially the detail of the inner portions of the corona.

Prof. Turner. I propose to repeat the same programme that I hoped to carry out in Japan—that is, to take photographs on a smaller scale, and also to use a polarizing apparatus with the intention of measuring the intensity of the polarization. The only improvement I have made upon the Japan arrangements I am afraid will not be of any use. I have constructed a hut for the instrument and the observer on a better principle. We had a bother with the window and the opening, so I have made a hut in such a way that any section of it can be taken to pieces by taking out a series of thumb-screws. In about 10 minutes the whole hut

can be pulled to pieces. But this time we are not going to take any huts with us. I believe that various persons, including the Asiatic Society of Bengal, have been doing a vast amount of work for us out there, and I think we shall find many things already prepared. If the weather only is favourable, I hope and believe we shall come back with a better story to tell you than last time.

The Chairman. There is one point I have heard with great satisfaction. For some years past the expediency and desirability of the corona being photographed on collodion plates has been urged. Some of us have known how far superior were the results of 1887 to those of more recent years. It is a great satisfaction to know from the Astronomer Royal that he is going to make a trial of collodion plates. Knowing that the grain is so fine, we shall look with considerable interest to the results that he is able to report.

The Astronomer Royal. From the experiments we have been making at Greenwich with these dry collodion plates, we have found that the fastest collodion plates which we could obtain required four times the exposure of the fastest gelatine plates, so they are not what would be called slow plates. We could get slow plates, but with those we have been using at Greenwich our object has been to get the quickest dry collodion plates we could for photographing the Moon, and we found that with dry collodion plates we required four times the exposure that was necessary with the most rapid gelatine plates. We can photograph the Moon certainly in one or two seconds, whereas only from a quarter to half a second would be required with the special rapid gelatine plates we use.

The Chairman did not think the relative speeds were as stated. The dry collodion plates were much slower.

The following papers were announced and partly read :—

G. Rümker. "Occultation of Ceres by the Moon on 1897 November 13, observed at the Hamburg Observatory."

W. H. Finlay. "A Determination of the Latitude Variation and of the Constant of Aberration from Observations made at the Royal Observatory, Cape of Good Hope, 1892-94."

R. T. A. Innes. "The Binary Star α 5014."

"Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1895, deduced from Photographs taken at the Royal Observatory, Greenwich, at Dehra Dûn (India), and in Mauritius." (Communicated by *the Astronomer Royal*.)

T. H. Safford. "Further Note on Personal Equation."

Royal Observatory, Greenwich. "Proper Motion of the Three close Polar Stars Groombridge 1119, Groombridge 2283, and Groombridge 3548."

Radcliffe Observatory, Oxford. "Observations of Meteors on 1897 November 13-15."

Radcliffe Observatory, Oxford. "Occultation of the Planet Ceres by the Moon on 1897 November 13."

The following gentleman was elected a Fellow of the Society:—

William James Stewart Lockyer, M.A., Ph.D., 16 Penywern Road, South Kensington, S.W.

The following Candidates were proposed for election as Fellows of the Society:—

Samuel Cooke, M.A., Principal of the College of Science, Poona, 2 Mortimer Road, Clifton, Bristol (proposed by Sir R. S. Ball).

Thomas Charlton Hudson, B.A., Nautical Almanac Office, 3 Verulam Buildings, Gray's Inn, W.C. (proposed by Dr. Downing).

David Hunter, John o' Groat's Villa, Cambuslang, Glasgow (proposed by John Dansken).

Alfred E. Larkman, Navigation Teacher, 56 Colville Road, Leytonstone, E. (proposed by W. E. Plummer).

Edmund Taylor Whittaker, B.A., Fellow of Trinity College, Cambridge (proposed by Sir R. S. Ball).

Walter Wickham, First Assistant, Radcliffe Observatory, Oxford (proposed by A. A. Rambaut).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE first ordinary Meeting of the Eighth Session of the British Astronomical Association was held at Sion College, on Wednesday, November 24th, the President, *Mr. N. E. Green*, in the Chair.

The election of 19 new members was confirmed and the names of 11 Candidates for membership were read and suspended.

Mr. E. W. Maunder said that owing to the spread of the plague in the country districts round Poona the Eclipse Committee had been compelled to entirely recast their plans. One party would sail for Bombay on the 8th December and would probably proceed by rail to Nagpur, where they would make the best arrangements they could for camping out on the central line. The rest of the party would go out a fortnight later and would proceed from Bombay to Allahabad or Benares at once. The members of this party had either very small telescopes which could be readily set up or were going to take visual observations of the eclipse. From Benares to Buxar, which was on the central line, was a short railway journey, which could be performed on the day of the eclipse. The government party would be divided into several sections. Sir Norman Lockyer and party would probably occupy a position at Vizianagur on the west coast. The staff of the Madras Observatory would probably be stationed at Karad, where the railway line crosses the line of totality. Prof. Naegamvala, of the

College of Science, Poona, and a numerous party, would occupy the next station on a second line of railway at Jeur. The next party would consist of Capt. Hills and Mr. Newall. The astronomer Royal and Prof. Turner would probably go as far as Jubbulpur, from which point they could reach the line of totality by rail at a place called Sohagpur. Between the last two stations another official post would be occupied by Dr. Copeland, the Astronomer Royal for Scotland; and finally he hoped that one of their own members, Mr. J. W. Meares, residing at Darjeeling, would occupy a position in that neighbourhood. Thus there would be a complete line of stations from the coast right up to the Himalaya Mountains, so that they had every reason to hope that the unfortunate weather conditions which disappointed them so much in Norway would be avoided. Mr. Maunder, Mr. Thwaites, and Mr. Evershed then described in detail the instrumental equipment they were taking with them.

A paper on "The Sun's Velocity in Space," by *Mr. W. H. S. Monck*, was then read. The writer based his calculations (1) on the average velocity with which the stars, taken all round, approached or receded from a given point in the sky; and (2) the proportion of their velocity in a given direction which was due to the Sun's motion in space. He arrived at the conclusion that the velocity of the Sun in space was about 13 or 14 miles per second.

Miss Brown contributed "A Summary of Sun-spots for the half-year ending 30th Sept. last." The half-year had shown a steady though gradual approach to the minimum period. There had been a marked increase in the number of days when the Sun's disc was entirely free from spots, amounting to as many as 16 during the six months, as against 2 in the former half-year. August was remarkable for one fine spot, the largest observed during the period under review.

Mr. J. H. Jenkinson read a paper on "The Drawing of Sun-spots." He remarked that almost all the drawings of sun-spots he had seen, while admirable as "plans" of spots, altogether failed to convey any idea of what a spot was like in connection with the surrounding surface. The first thing that struck him was that a portion of the umbra was almost invariably visible when the spot was quite close to the limb, both in coming on and going off. Often, when the spot was very much foreshortened, it seemed to be up very nearly level with the farther edge of the penumbra. It was thus quite clear that, whatever the umbra might be, it was not a hole at the bottom of a deep basin-like depression. As there was no doubt that a spot showed itself as a depression, the question to be considered was, what would be the section of a sun-spot?

He had come to the conclusion that the section of an ordinary symmetrical sun-spot would, roughly speaking, very much resemble that of a large lunar crater. In comparing the section of a sun-spot, however, to that of a lunar crater he did not suggest that there was any resemblance between them in their proportions, for it was

obvious that a sun-spot was a depression of extreme shallowness. He took it to be a mere surface disturbance, though the forces that caused it might originate at a considerable depth below it. Another point that the attempt to draw sun-spots brought prominently to his notice was that in the neighbourhood of a spot there were always to be found a number of those elevated ridges of bright light to which the name of "faculæ" had been given.

The President remarked upon the high quality and artistic beauty of Mr. Jenkinson's drawings.

In reply to a question by Mr. Thwaites, *Mr. Jenkinson* said that he used a small instrument of his own contrivance, which enabled him to shut off all the Sun's disc except the spot he was observing and the surrounding region, which he could then observe with simply the protection of a dark glass.

Mr. Maunder said he had listened with great pleasure to Mr. Jenkinson's paper, because it had brought out with great clearness several points upon which his views were in accordance with those of the writer's. It appeared to him that sun-spots were unquestionably shallow depressions and that the umbra very frequently had a convex shape, so that it was highest in the centre. Mr. Maunder then proceeded to describe some interesting experiments by the Rev. Arthur East in the production of what might be called artificial sun-spots.

Captain Noble said he could bear testimony to the extreme conscientiousness and minute accuracy of Mr. Jenkinson's drawings.

Mr. Evershed said if the supposed convexity of the umbra of sun-spots was a fact, it implied that the darkness was really due to an opaque mass blotting out the photosphere. It was very important to determine whether this was so or not.

Dr. Johnstone Stoney stated his views on the extreme shallowness of the solar atmosphere. The enormous force of gravitation at the surface of the sun must make his atmosphere much shallower than that of our Earth.

A paper by *Dr. Pannkoek* was then read by *Mr. Schooling*, on "The Best Method of Observing the Milky Way." This was followed by a paper by *Mr. R. Parry*, on "A Theory of Lunar Formations," and one by *Mr. Charles F. Smith*, on "Ruined Lunar Formations." After some discussion on these papers the opinion of the Meeting was taken as to the most convenient place for holding the monthly meetings, the result of the vote being almost unanimously in favour of Sion College.

ROYAL METEOROLOGICAL SOCIETY.

THE monthly Meeting of this Society was held on Wednesday evening, 1897 December 15th, at the Institution of Civil Engineers, *Mr. E. Mawley*, F.R.H.S., President, in the Chair.

Mr. W. Marriott read a paper on the "Rainfall of Scathwaite,

Cumberland." This place has long been noted for its heavy rainfall, being in fact one of the wettest spots in the British Isles; the average yearly amount is 137 inches. The spring months of April, May, and June are the driest, so they not only have the least rainfall, but also the least number of rainy days. August, the month when the Lake District is thronged with visitors, has the greatest number of rainy days. The heavy nature of the rainfall may be gathered from the fact that 21 per cent. of the falls are above 1 inch, 2 per cent. being above 3 inches. The greatest fall in one day was 8·03 inches on 1897 November 12th. The author has investigated the atmospheric conditions under which the heavy rainfalls occurred at Seathwaite, and he finds that the heavy falls are due to the direction and force of the wind. When the wind is blowing strongly from the south-east or south-west, it will be concentrated in the valleys on the windward of Scafell, and rush up them with considerable force, the air-current consequently being projected to a considerable altitude beyond Scafell. Owing to the reduction of temperature with elevation, the air parts with a great deal of its moisture, which falls as rain. With such a process going on continuously for a whole day, the heavy rainfall at Seathwaite is fully accounted for.

Mr. R. C. Mossman, F.R.S.E., also read a paper "On the Daily Values of Non-instrumental Meteorological Phenomena in London from 1763 to 1896." The phenomena discussed were thunderstorms, lightning without thunder, fog, snow, hail, and gales.

*Notes on some Points connected with the Early History
of the 'Nautical Almanac.' **

ONE of the most valuable results of the progress of astronomical research in the middle of the last century, was the institution of the 'Nautical Almanac,' a work that has contributed much more than any other ephemeris towards the practical development of the sciences of astronomy, geography, and navigation, and which, in its modern and improved form, still continues the honoured *vade mecum* of the astronomer, the explorer, and the mariner of the present day. It has occurred to me that it may be appropriate to record in the 'Journal of the Royal Institution of Cornwall'—as a slight contribution to the scientific history of the county—a few personal notes hitherto unpublished, chiefly relating to the association of a well-known Cornish "worthy" with the compilation of the early volumes of the first series of that work.

* [These notes by Mr. Edwin Dunkin, F.R.S., sometime President of the R.A.S., and Chief Assistant at Greenwich, were published originally in the 'Journal of the Royal Institution of Cornwall,' no. xxxii. vol. 9, 1886. Some excision has been made of paragraphs which are of purely local interest, and some notes, the authorship of which has been duly noted, added.—Ems.]

As our national ephemeris has now become the necessary companion, or handbook, of sailors of all nations, as well as of astronomers, any information not generally known, in relation to its early history, cannot fail to be appreciated by men of science, especially in Cornwall, in whose towns and villages a very considerable portion of the calculations were made between the years 1775 and 1831. In the latter year the Nautical Almanac Office, as it exists at present, was permanently established in London, in which all the calculations are now made.

It must be understood that the publication of a nautical ephemeris of any real scientific value was not possible before the middle of the last century, as even at that time very imperfect materials were in existence from which any reliable astronomical predictions could be made, especially of stated daily positions of the Moon. It is true that observations of our satellite had been made before 1740 by Dr. Halley with the mural quadrant at the Royal Observatory, and that lunar tables had been formed by him and others; but it was not till after the publication in 1752 of his astronomical tables for computing the places of the Sun and Moon, prepared by him before he became Astronomer Royal in 1720, that the residual errors, determined from a comparison of these lunar tables with the Greenwich meridional observations of the Moon, made between 1722 and 1739, were found to be far too great for the tables to be of much practical value for the determination of the longitude at sea, though they were in advance of others that had preceded them. It is probable, therefore, that the 'Nautical Almanac' would not have been established even in 1767, had not more accurate tables been constructed by Prof. Mayer, of Göttingen, founded on the more recent observations. Fortunately, in 1755, Prof. Mayer transmitted his tables in manuscript to Dr. Bradley, who deemed them to be so accurate that, by using the calculated places of the Moon, they might serve in finding the longitude at sea within half a degree of the truth, and generally much nearer. After the death of Mayer in 1762, these manuscript tables were placed in the hands of Dr. Maskelyne, who also considered them sufficiently accurate for general nautical purposes, and by him they were laid before the Board of Longitude as a work of both scientific and national importance*.

* The "Board of Longitude" was formed by the Government for the encouragement of nautical science, and especially of the problem of finding the longitude at sea, by instituting rewards to such person or persons as shall discover a method for finding the same, or shall make useful discoveries in navigation. The 'Nautical Almanac' owes its existence to a memorial presented to the Commissioners of Longitude by Dr. Maskelyne, on February 9, 1765, in which he stated many facts and experiments to prove the utility of determining the longitude at sea by the lunar method. On his recommendation the Board resolved that an application should be made to Government to grant a reward to the representatives of Mayer for his tables; and "also for power to give a reward to persons to compile a nautical ephemeris, and for authority to print the same, when compiled, in order to make the said lunar tables of general utility."

Before, however, the tables of Mayer could be made practically available, even when printed, it was necessary that some means should be found to obviate the difficulty that would be experienced at sea on account of the intricate calculations required to obtain accurate tabular places of the Sun and Moon, an operation that the most scientific navigator could hardly be expected to undertake.

To remove this difficulty, Dr. Maskelyne proposed to the Board of Longitude that the positions of the Sun for noon, and of the Moon for noon and midnight, should be calculated for each day by Mayer's tables, and that these positions, with other astronomical information useful to the mariner, should be incorporated into a '*Nautical Almanac*,' appearing one or more years in advance. Dr. Maskelyne, who had just been appointed Astronomer Royal, undertook the responsibility of its preparation, and he continued its superintendent till his death in 1811. The first Almanac was published in 1766 for the following year, in the preface of which he remarks that "the difficulty and length of the necessary calculations seemed the only obstacles to hinder Mayer's tables from becoming of general use; to remove which this ephemeris was made, the mariner being hereby relieved from the necessity of calculating the Moon's place from the tables, and afterwards computing the distance to seconds by logarithms, which are the principal and only very delicate part of the calendar; so that the finding the longitude by the help of the ephemeris is now in a manner reduced to the computation of the time, an operation equal to that of an azimuth, and the correction of the distance on account of refraction and parallax."

By these tables of Mayer, the power of calculating comparatively accurate positions of the Sun and Moon was much facilitated, and so important was this considered by the Astronomer Royal and the Board of Longitude, that, on the recommendation of the latter, an Act of Parliament was passed empowering the Government to award the munificent gratuity of £3000 to Mayer's widow, and £300 to Euler, who had furnished the theorems made use of by Mayer in the construction of the theory. These tables were published at the expense of the British Government in 1770, and a new edition, improved by Charles Mason, appeared in 1787*.

In the preparation of the initiatory volume of the '*Nautical Almanac*' for 1767, several persons were necessarily employed on the calculations, most of which were computed in duplicate by two separate persons, and examined by a third. As the computers were under the direct supervision of Dr. Maskelyne, the first volumes were probably calculated within the walls of the Royal Observatory, but I can find no record of these early computations. One of the computers, as stated in Davies Gilbert's '*Parochial History of Cornwall*,' and other histories, was the distinguished

* Copies of both of these editions, formerly belonging to the Rev. Malachy Hitchins, are in my possession.

Cornishman, Malachy Hitchins, afterwards vicar of St. Hilary in 1775, and of Gwinear in 1785*. How long he resided at Greenwich I cannot ascertain, but I believe it was only for a short period in 1766 and 1767, till he became fully acquainted with the Astronomer Royal's plans for carrying on the computations†. For more than forty years, however, he continued to be the able coadjutor of Dr. Maskelyne as the comparer of the 'Nautical Almanac,' and the confidential correspondent on many matters connected with its administration, though his name and services do not appear to have been acknowledged in the prefaces of the various Almanacs.

There can be no doubt that Dr. Maskelyne had a very favourable opinion of Malachy Hitchins as a painstaking calculator, for though he was only about 25 or 26 years of age when he became one of the early computers of the Almanac, he was in a few years entrusted with the far more responsible duty of comparer of the calculations performed by other computers at their private residences in various parts of the country. As the comparer, therefore, all the calculations were sent to Mr. Hitchins for revision. If the corresponding portions of the work calculated by different computers were found to be in agreement, they were passed as correct; but if not, then it was the duty of Mr. Hitchins to discover in which computer's work the error lay. When finally satisfied as to the accuracy of the calculations, they were forwarded by him to Dr. Maskelyne in a fit and proper state for the press. It seems almost incredible, in this present age of rapid communication, that our recollections can be carried back to a time when heavy forms of calculations had to be transmitted, in some cases, several hundred miles for verification, and that this system should have continued during so long a period, especially in the epoch of slow travelling and expensive postage. Probably Mr. Hitchins endeavoured to avoid this inconvenience as much as possible; hence the reason why so many Cornishmen were employed on the first series of the work, for doubtless his influence was sufficient to induce Dr. Maskelyne to permit him to engage several computers from his own neighbourhood. Sometime about the year 1804 my father was introduced to Mr. Hitchins by that eminent scientific Cornishman, Davies Gilbert, F.R.S.‡, who had oppor-

* Both these benefices were retained by Mr. Hitchins till his death, on March 28th, 1809.

† In the early months of 1769 Mr. Hitchins was evidently not residing at Greenwich, as Dr. Maskelyne has stated that he came to the Observatory in that year *specially* to assist in the observations about the time of the transit of Venus. His family is believed to have generally resided in Devonshire, both before and after his introduction to Dr. Maskelyne, sometime at or near Exeter, till his institution to the Vicarage of St. Hilary, on November 6th, 1775, on the death of the Rev. John Penneck.

‡ Mr. Davies Gilbert succeeded Sir Humphry Davy as President of the Royal Society on Nov. 6th, 1827. He was in 1820 one of the original Fellows of the Royal Astronomical Society, and filled the office of Vice-President at intervals from its foundation till his death on Dec. 24th, 1839. He was also M.P. for Helston, 1804-6, and for Bodmin from 1806 to 1832.

tunities at St. Erth of noticing his mathematical acquirements. This introduction led to his appointment by Dr. Maskelyne as one of the computers of the 'Nautical Almanac'; and on taking up his residence at St. Hilary he became the confidential companion and assistant of Mr. Hitchins. On the death of that gentleman in 1809 the computations were thrown into considerable confusion, as it was not easy to find a properly qualified person immediately to undertake the important office of comparer. In consequence of this, many additional duties devolved, for a time, on my father, at the request of Dr. Maskelyne, with whom, and afterwards with Mr. Pond, F.R.S., Astronomer Royal, and Dr. Thomas Young, F.R.S., who in 1818 succeeded to the superintendence of the Almanac, he continued to carry on a direct official correspondence. My father, who was generally responsible for the preparation of five months of the Almanac, from May to September, resided several years at St. Hilary, but in the year 1813 or 1814 he removed to Truro.

From my early recollections of my father during the later years of his residence in Cornwall, I can, even at this distant time, fully remember many of the inconveniences that he, and probably also all the computers, experienced in consequence of their scattered residences. These were in all parts of the country. About the year 1828, up to the time when the office was established in London in 1831, I find that about six computers besides the comparer were employed—at Arbroath, N.B., Cornwall (3)*, London, Ludlow, and the Comparer at Tideswell. When a difficulty arose requiring a reference to the superintendent or comparer, weeks and sometimes months elapsed before an answer could be obtained; and usually the computations meanwhile remained at a standstill. These delays were of frequent occurrence, particularly in the winter months.

[To be continued.]

The Yerkes Observatory.

WE have been favoured with cuttings from the 'Chicago Times-Herald' of Oct. 21 and 23 last, which give, in the breezy manner peculiar to American papers, a graphic account of the opening of the Yerkes Observatory, with pictures of the principal persons concerned. This account of the great event commands too much space to be reprinted here in full; but a sufficiently intelligible account of the proceedings, which followed the programme given in our number for October last, may be gathered from the extracts which we give below. The list of scientists who took part contains about sixty names, and of other persons there were nearly four

* The three Cornishmen were Mr. William Dunkin, at Truro; Mr. Nicholas James, at St. Hilary; and Mr. Richard Martin, at St. Mabyn. Of these, my father alone was transferred to the London office in 1832.

hundred; for whom, as the newspaper states, it was no small problem for Prof. Hale to provide entertainment and means of transport. The first extract gives a general view of the proceedings at the function:—

Professor Hale finds that the congress, gathered from all the leading observatories in the country, has but one opinion. The members sit for hours during the reading of profound theses, and then slip up into the dome to admire the heavenly leviathan.

Professor Newcomb made his statement after an examination this afternoon. Professor George W. Hough, of Northwestern University, came from the wonder a few minutes later, and ventured a prediction that this is to be the spot where all astronomical eyes shall look in the future.

President Harper will preside, introducing Mr. Yerkes, who has now a quasi-claim to the observatory. His part will be the formal presentation. Martin A. Ryerson, president of the university board of trustees, will accept the donation, and then Professor James E. Keeler, of Allegheny, will deliver the address of the occasion. This will end the formalities. The rest of the day is to be spent in looking over the observatory and at luncheon.

This simple ceremony will start the institution on its career and end the functions over it. There is yet much to be done, but from this time on Professor Hale and his faculty will square themselves for purely astronomical work, uninterrupted by conferences, society, and functions. They hope to come to the full realization of all the hopes of the noted men they have been entertaining for the week.

A conference so weighty as an astronomical conference moves slowly. Professor C. L. Doolittle, of the University of Pennsylvania, started to-day's programme on time with a talk on latitude work; but the talks were invariably longer than provided for in the schedule arranged by Professor Hale. The minute a man makes an assertion there are a dozen who want to put him on the inquisitorial rack, and for an hour there will follow an impromptu battle of scientific giants in words and combinations of words which are beyond fairly good comprehension, and without the bounds of ordinary powers of orthography.

Professor Hale had arranged for a little dessert in the evening after the above programme had been carried out. He was to show some of the workings of the telescope, but a star opposite this event referred to a footnote, which announced the bill was subject to change. Professor Garriott, in the Chicago weather office, took advantage of the footnote. He filled the sky with clouds all day, and put a double blanket on in the evening. This stopped any practical demonstrations for the day, and when the Sun supposedly had gone down the conference took up its addresses for another session. Lectures were delivered by Professor Barnard, Father Hagen of the Georgetown University, Professor Hough of the Northwestern University, Professor G. W. Myers of the University of Illinois, Professor Newcomb and Professor Pickering of the Harvard College Observatory.

The newspaper furnishes no account of Prof. Keeler's scholarly address, which is published in the 'Astrophysical Journal.' Prof. Newcomb's oration on the "Aspects of American Astronomy" is given in full. We give some extracts from this below, prefacing them with a paragraph which explains itself. The "example" referred to is Prof. Burnham, who is playfully called by the journalist "the little man":—

Professor Newcomb had got well along in his eloquent oration on the "Aspects of American Astronomy." He had recited the great work that had

been done by American astronomers, and began a line of reasoning to the effect that it was not always the man who had the biggest telescope who had done the most remarkable work. He had known of men who had had no telescope at all, and had been able to build an astronomical fame from the resources of scientific libraries. He said he had a striking illustration that the value of an astronomer could not be rated in proportion to the length of his telescope very close at hand and right in Chicago. He intimated that he suspected that the instrument his example used was not longer than a man's arms, but that it had taken the name of the example into the cluster of great astronomers of the century.

But neither the measurement of the Earth, the making of maps, nor the aid of the navigator is the main object which the astronomers of to-day have in view. If they do not quite share the sentiment of that eminent mathematician who is said to have thanked God that his science was one which could not be prostituted to any useful purpose, they still know well that to keep utilitarian objects in view would only handicap them in their work. Consequently they never ask in what way their science is going to benefit mankind. . . . That we now look upon a comet as something very interesting, of which the sight affords us a pleasure unmingled with fear of war, pestilence, or other calamity, and of which we therefore wish the return, is a gain that we cannot measure by money.

It is pleasant to be one of a brotherhood extending over the world, in which no rivalry exists except that which comes out of trying to do better work than anyone else, while mutual admiration stifles jealousy. And yet, with all these advantages, the experience of the astronomer may have its dark side. As he sees his field widening faster than he can advance he is impressed with the littleness of all that can be done in one short life. He feels the same want of successors to pursue his work that the founder of a dynasty may feel for heirs to occupy his throne. He has no desire to figure in history as a Napoleon of science, whose conquests must terminate with his life. Even during his active career his work may be of such a kind as to require the cooperation of others and the active support of the public. If he is disappointed in commanding these requirements, if he finds neither co-operation nor support, if some great scheme to which he may have devoted much of his life, thus proves to be only a castle in the air, he may feel that nature has dealt hardly with him in not endowing him with passions like to those of other men.

Prof. Hale's address is also given in the November number of the '*Astrophysical Journal*.' The following extracts from this are of a more scientific character than those given above:—

The resolving power of the 40-inch telescope has been tested by Professors Burnham and Barnard by observing very close double stars. Such an object as κ Pegasi, the components of which are now less than a tenth of a second apart, was clearly and beautifully seen as an elongated disc under a power of 2080. As the theoretical resolving-power is about one-tenth of a second, this observation could not have been more satisfactory.

Close doubles have been seen by Prof. Barnard with a power of 3750, and defined sufficiently well for micrometric measurements. Atmospheric conditions which will permit the use of a power of 3750 must have been of the very best, and not to be expected very often; still Prof. Barnard has found that the best nights are fully as good as at Lick, though the average sight-seeing is not so good.

Perhaps the best proof that the light-gathering power is as good as might be expected is afforded by Prof. Barnard's observation of a new companion to Vega, which had not been seen with the 36-inch Lick refractor.

The steadiness of the mounting is remarkable.

Personally, I have seen the details in the solar chromosphere and prominences beautifully defined under a power as high as 600, which would usually be regarded as excessive for the work. But the special advantages of this satisfactory combination of good atmospherical and instrumental conditions have been most clearly emphasized in observations of the spectrum at the Sun's limb. It has been found that the quiet chromosphere gives many bright lines not hitherto recorded, even in the case of violent eruptions. Among these we may probably include the green fluting of carbon. So many new lines have already been seen that it seems desirable to undertake a complete revision of the chromospheric spectrum.

The success of these various tests convinces me of the desirability of carrying into effect the plan of work mapped out for this Observatory in 1892. This includes various classes of solar investigation; micrometrical observations of double stars, planets, satellites, nebulae, comets, &c.; parallax work; photographic studies of stellar spectra, including determinations of motion in the line of sight; and various physical researches in the laboratories. It is the ambition of the members of the Observatory Staff that the work to be done here shall acquire a reputation for thorough reliability. We mean to do all we can to discourage sensationalism, the evils of which have been only too apparent in recent astronomical literature.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Periodical Comets due in 1898.

GENTLEMEN,—

Of the known periodical comets which have been observed at more than one return, three are due to return to perihelion next year.

Of the previous appearances of one of these, commonly called Winnecke's, I have spoken sufficiently in the last number of the 'Observatory.' It will be due in perihelion on the 20th of March, but will probably become visible before the end of the present month.

The second is the comet which, although its history cannot be traced further back than 1786, has been observed, on account of the shortness of its period, at a greater number of appearances than any other. I speak of course of that known as Encke's, the next perihelion passage of which will be due about the end of May. We are grateful to this comet for furnishing the earliest means of determining the mass of the planet Mercury, to which it occasionally makes near approaches. And great interest still attaches to its continued observation for the investigation of the cause of those remarkable alterations in its mean motion which Encke attributed to the effects of a resisting medium in space, but for which another explanation must be sought since the diminution in the amount of the retardation has been substantiated. Possibly this may ultimately be found in pertur-

bations produced by some of the small planets, though it is strange that the effect should have been nearly uniform during many years. When Encke put forth his theory, which then seemed so plausible, only four of the small planets were known; we now know of more than four hundred, but are not much nearer being able to trace the effects of their attraction, which may sensibly influence the motions of those comets which pass near them.

The last of the three periodical comets due in 1898 will probably return to perihelion towards the end of the summer. It is called Wolf's, and was first discovered by Prof. Max Wolf at Heidelberg on the 17th of September 1884, about two months before its perihelion passage. Calculated to be moving in an elliptic orbit with a period of somewhat less than seven years, it duly returned to view in 1891, when it was first seen by Dr. Spitaler, of Vienna, on the 1st of May, and passed its perihelion on the 3rd of September, so that it will probably become visible again early next summer.

Yours faithfully,

Blackheath, 1897, Dec. 8.

W. T. LYNN.

OBSERVATORIES.

[Continued from Vol. xx. p. 458.]

MUNICH.—Herr Bauschinger severed his long and honourable connection with the Observatory on being elected to a Professorship in the University at Berlin. The Repsold meridian circle was used by Herr Bauschinger and his successor, Herr Oertel, for the purpose of compiling a catalogue of zenith stars. Herr Villiger made numerous observations of 45 minor planets with the 10½-inch refractor. Observations of the following comets were made:—Perrine-Lamp 1896 I.; Perrine 1895 IV. (1896 II.); Swift 1896 III.; Sperra 1896 IV.; Giacobini 1896 V.; Brooks 1889 V. (1896 VI.); Perrine 1896 VIII.; Perrine 1896 VII. Eleven drawings were made of Venus and twenty-seven of Mercury. The surfaces also of Jupiter and Saturn were examined, and measures of the ring made as follows:—

Outer Ring....	(preceding) 11"·30	(following) 11"·30.
Cassini	„ 8·62	„ 8·56.

Forty-seven double stars were measured. Meteorology. Time Service.

POTSDAM.—Herr Wilsing, with the photographic refractor, obtained 11 spectrographs of Mira Ceti very rich in detail, the hydrogen lines being especially bright. He is also engaged in classifying the star-spectra to the 5th magnitude. Dr. Clemens obtained a good series of spectrographs of α Aquilæ, while Dr. Lohse continued his researches of the spectra of metals

between $\lambda 400 \mu\mu$ and $\lambda 460 \mu\mu$. The study of the surfaces of Mars and Jupiter and measures of planetary diameters was carried on by Dr. Lohse with the 11-inch refractor. Prof. Müller was engaged on the Photometric Durchmusterung of the northern heavens. The work on the photographic chart of the sky has been regularly carried on by Prof. Scheiner and Miss Everett. Owing to the unfavourable state of the weather only 625 plates out of 781 have been considered good. During the year 51 plates were measured, so that up to now 117 plates, containing 41,000 stars, have been measured, and of these 11,500 have been catalogued.

STRASBURG.—The work with the transit-circle consisted of fundamental places of stars of the 7th mag. and brighter between 60° and 90° N. Decl., regular observations of the principal planets and the Sun. The refractor was employed for observation of nebulae and the determination of places of faint comparison stars. The following comets were observed:—Perrine 1895 IV.; Perrine 1896 I.; Swift 1896 III.; Brooks 1896 IV.; Giacobini 1896 V.; Brooks 1889 V.; Perrine 1896 VII.; Perrine 1897.

UTRECHT.—Observations of comets:—Perrine-Lamp; Perrine 1896 I.; Swift; Brooks; Giacobini; Perrine 1896 II. The following variable stars received particular attention:— α Ceti, δ Cephei, η Aquilæ, ϵ Aurigæ, ρ Persei, β Lyræ. Twenty-four drawings were made of Jupiter, and 36 phenomena of the satellites recorded. Meteorology.

VIENNA. *M. Edler v. Kuffner*.—With the meridian circle 1487 zone-observations were made. Dr. Schwarzschild took photographs of variable stars, and made experiments in connection with the magnitude of photographic star-discs.

ZURICH.—Over 200 photographs of the Sun were taken (diameter of disc = 95 mm.). The record of observation with the 4-inch refractor is:—

	No. of days of Observation.	Days of no Spots.	Relative Number.
1895.....	296	0	63.9
1896.....	258	5	40.5

YALE.—The Report of Dr. Elkin, dated 1897 June 23, on the astronomical work at the Yale University Observatory during the preceding twelve months does not err on the side of length, owing, we regret to say, to a severe attack of influenza, which compelled the Director to curtail his observing and to take a necessary holiday. Last year Dr. Elkin reported on some experiments he had made in photographing meteors, which had then met with little success. He now states that the apparatus for this purpose has been amplified by the addition of four lenses of six inches aperture each, which have been presented by C. S. Brainerd, Esq. Five lenses were put in use in 1896 August, and eight meteor-

trails, five of them Perseids, were secured. The showers of 1896 November and December were, however, unproductive.

A portion of the work on the parallaxes of the ten first magnitude stars of the northern hemisphere has been passed for press. The provisional results for these, which will probably be modified very little, are given in the Report *.

Dr. Chase, besides the work of the time service, which he superintends, and his teaching duties, has taken up the heliometer work on the parallaxes of stars with large proper motion.

PUBLICATIONS.

POULKOVA RIGHT ASCENSIONS OF CIRCUMPOLAR STARS.—The Bulletin of the St. Petersburg Academy for 1897, June, contains a memoir, by M. Morine, on the determination of Right Ascension of 115 circumpolar stars from observations made during 1893 with the Poulkova meridian-circle. This subject is of such interest to those who work at astronomy of position that the Catalogue and its formation deserve consideration with some detail.

The Catalogue contains stars to the 7th magnitude in the zone $+80^{\circ}$ to $+89^{\circ}$. In the reduction the eleven stars contained in the 'Berliner Jahrbuch' have been used for determination of azimuth error. Each star, according to the programme laid down, was to be observed eight times over five symmetrical wires, both above and below pole in both positions of the instrument, which is reversible.

It was found that there was a nearly constant difference in the azimuth error as determined by transits above and below pole. Half of this discordance was applied as systematic correction to azimuth errors determined above pole, and half with the opposite sign to those determined from transits below pole. Then, after the mean for the day was formed from these, the correction was again applied in one direction to observations above pole, and in the other to observations below pole.

By this method the discordances of R.A. determined above and below pole, and also in the two positions of the instrument, were much reduced. Tables of these corrections for each degree of declination from $+80^{\circ}$ to $+89^{\circ}$ are given, and also the probable error of a single observation of Right Ascension for each of those zones, which range from $0''.01$ to $0''.02$ when reduced to their equivalent in arc on the equator.

Thirty of the stars reduced to the same epoch appear in the volume of Greenwich Observations for 1893. In this reduction no correction for the apparent discordance above and below has been

* These results are given on p. 67.

applied. Most of the Greenwich places depend on single observations; but in no case does the difference between the Greenwich and Poulkova determination amount to 2 seconds of arc.

The places of the following stars, which were observed at least four times at Greenwich in 1893, have been compared with those of the Poulkova Catalogue:—

Poulkova No.	Zones.	Star's Name.	No. of Obs. Gwh.	Gwh.-Plk. Equat. Arc.
34	88-9	Groombridge 1119 ..	50	-0'33
59	88-9	Bradley 1672	43	+0'13
70	83-4	Piazzi xiii. 263.....	4	-0'04
77	81-2	Lalande F. 2589	5	-0'78
79	87-8	Groombridge 2283 ..	20	-0'14
88	83-4	Bradley 2412	5	+0'48
101	81-2	Bradley 2701	14	+0'40
102	81-2	75 Draconis	10	+0'51
111	86-7	Groombridge 3548 ..	18	+0'25
113	85-6	Bradley 2993	39	+0'16
121	86-7	Bradley 3147	34	-0'13

Of the eleven stars used at Poulkova for determination of azimuth error only four have been used at Greenwich, the rest being more than 4° from the pole; and the ephemeris used at Greenwich in 1893 was not the 'Berliner Jahrbuch,' but the 'Connaissance des Temps,' with a correction to the mean places determined from Greenwich observations.

The following are these systematic differences for 1893:—

	Greenwich—C.T.	Greenwich—B.J.
	^s	^s
Polaris	+0'88	-0'27
Cephei 51	-1'31	-0'63
δ Ursæ Minoris	-0'65	-0'09
λ Ursæ Minoris	+0'32	-0'32

So that for the stars common to both reductions the plans used at Greenwich do not differ widely from those used by M. Morine.

Whatever be the cause of the discordance between observations above and below the pole it is satisfactory to note that it does not much affect the mean places as determined from both combinations, whatever be the special system of reduction adopted, and it would also appear that the sign of the Greenwich-Poulkova discordances not being systematic tends to confirm the idea, suggested by their small magnitude, that they are to a great extent accidental.

W. W. B.

THE PARIS CATALOGUE, VOLUME III.—It may be scarcely necessary to mention that one of the great works that has been in progress at the National Observatory, Paris, during the last ten

years or so, is the compilation of a huge catalogue, depending on re-observations of the 47,390 stars of Lalande's Catalogue, which were made between the years 1837 and 1881, with the various meridian instruments of the observatory. The observations are divided into three sections, according to the period in which they were made, and are all reduced to one of the three epochs, 1845, 1860, 1875, so that there are practically three catalogues in one. The work is being produced in volumes. The first appeared in 1887; the second in 1891; and the third, which contains 8652 stars between Right Ascension 12^h and 18^h , is recently to hand. The arrangement naturally is the same as that of the earlier volumes, and, like those, contains the determination of the Proper Motion of many stars. This volume, which has had the advantage of several recently published catalogues for these investigations, contains 350 annual Proper Motions, about half a dozen of which exceed $1''$. The numerous corrections to Baily's 'Lalande Catalogue,' which have been detected from comparison with the present catalogue, should be valuable, as should also the comparison between the Paris places and those of Auwers' 'Bradley Catalogue.' MM. Gaillot and Bossert are to be congratulated on the progress of their monumental work. W. W. B.

OBSERVATIONAL ASTRONOMY*.—Some years ago we had occasion to write in these pages a little severely of a book by Mr. Arthur Mee under this title. The Author has now favoured us with a copy of the second edition of his work, which, save for the title, has little in common with its predecessor. This might be described as a "chatty" book on elementary astronomy, or possibly "an astronomical scrap-book" would fit it better. The arrangement, so far as we remember, is that of the first edition: an introductory chapter on the elementary facts of astronomy is followed by one on the history and development of the telescope, and this by chapters on each of the celestial objects in turn. The book is written in paragraphs, each relating to special points connected by their subject, and is profusely illustrated by neat little pictures of the Sun, Moon, and planets, of telescopes, observatories, and astronomers; these last, in many cases, are not very good likenesses but they suffice to give the reader a general idea of the manner of man that each subject is. There is a good deal of information in the book for half-a-crown; and though the book is described as a practical book for amateurs, there is no reason why it should not find a place in a general astronomical library. But we must certainly call Mr. Mee's attention to a very serious mistake that he has allowed to pass. The picture on the cover of the book represents an elderly gentleman observing with a portable telescope a sky overcrowded with bright stars at a

* 'Observational Astronomy,' by Arthur Mee, F.R.A.S. 2nd edition. Cardiff. 1897. 2s. 6d.

time when the crescent Moon is nearly setting, *and there are two or three stars within the boundary of the invisible limb of the Moon.*

ROUSDON OBSERVATIONS.—We have received from Mr. Cuthbert E. Peek the first of a series of observations of variable stars made at his observatory at Lyme Regis. The book, which is numbered “2” (No. 1, containing the Introduction, will be published subsequently), contains the record of the observations of T Ursæ Majoris and S Cephei made by Mr. Peek or his Assistant, Mr. Grover, in the years 1887 to 1896. Each observation is the mean of five visual comparisons with stars in the same field of view as the variable, whose magnitudes are known. The instrument was a 6·4-inch equatorial by Merz. The results, besides being given concisely in tabular form, are plotted to form curves, so that one may easily grasp their significance. This pamphlet, though small, is no doubt the beginning of a valuable contribution to this branch of astronomy.

NOTES.

COMET NOTES.—By the end of November Perrine’s Comet had become too faint for accurate observation. The nucleus was entirely invisible, and the whole comet was a faint ill-defined glow 3’ long by 1’ wide. The latest observation to hand was made at Northfield on Nov. 23 (‘Popular Astronomy,’ Dec.).

The following is an approximate ephemeris for Greenwich midnight:—

R.A.					N. Dec.		R.A.					N. Dec.	
		h	m	s	°	'			h	m	s	°	'
Jan. 2....	18	2	40	45	16		Jan. 10....	18	1	20	44	25	
6....	18	2	0	44	48								

The following additional orbits have been published:—

H. C. Wilson.				Möller.			
Ast. Journ. No. 420.				Ast. Nach. No. 3459.			
T = 1897	Dec. 8·9216	G.M.T.		1897	Dec. 8·6899	G.M.T.	
ω	66° 10’ 11”			65° 56’ 34”			
Ω	32 4 9			32 3 27			
i	69 37 21			69 36 36			
log q	0·13186			0·13242			

Mr. Wilson says: “The bright streak in the tail was so nearly equal in brightness to the very slight condensation about the nucleus that observers with small telescopes would be likely to bisect the streak rather than the nucleus, and their observations might therefore be 1’ or 2’ in error.”

The following search ephemeris of Winnecke's Comet is by Hillebrand (Ast. Nach. 3447):—

	R.A.			S. Dec.			R.A.			S. Dec.
	h	m	s				h	m	s	
Jan. 2....	15	18	24	3	55	Jan. 18....	16	20	0	7 42
6....	15	32	53	4	52	22....	16	36	59	8 37
10....	15	47	58	5	49	26....	16	54	36	9 30
14....	16	3	40	6	46	30....	17	12	49	10 21

A. C. D. C.

MINOR PLANET NOTES.—Four new planets have been discovered by Charlois: DL on Nov. 23, DM, DN, DO on Dec. 18. This brings the total number of discoveries during 1897 up to 8, which is still considerably below the average of recent years.

A. C. D. C.

OBITUARY.—We regret to have to record the death of Dr. Winnecke, of Strasburg, which occurred on December 2 last.

August Friedrich Theodor Winnecke was born on 1835, February 5. After receiving his early education at the Lyceum in Hanover, at Michaelmas 1853 he joined the University of Göttingen, and studied astronomy under Prof. Encke. Later he worked at the Bonn Observatory under Argelander, where he learnt the use of the heliometer and employed this instrument to make a long series of observations for determination of stellar parallaxes, and also in making a complete triangulation of the stars of the Præsepe cluster, which, however, was not published until many years later. Through the influence of Wilhelm Struve, in 1858, he left Bonn and joined the staff at Poulkova, of which observatory he became Vice-Director; he remained here until 1867, when he was induced to give up his post and take up his residence in the more congenial climate and neighbourhood of Karlsruhe, where he still occupied himself in astronomical work. After the Franco-German war, when the foundation of a new German observatory was contemplated, Dr. Winnecke was chosen as Director, and the building and equipment of the present Observatory at Strasburg are due to his organization.

Dr. Winnecke's name will probably be remembered chiefly for the discovery of comets, which bear his name. Cometary astronomy was a subject to which he particularly devoted himself, for, besides making discoveries of comets, he published orbits and elements, and himself made a long series of observations of the comet of 1861 with the Poulkova equatorial. But besides this line of work he also had others. The memoir which obtained for him his Doctor's degree was on the double star η Coronæ: from an investigation of the observations of Mars during the opposition of 1862 he deduced a value of the Solar Parallax $8''.964$; also he took part with Col. Forsch and Capt. Zyilinski in the determination

of the arc of longitude between Poulkova and Greenwich, so that his astronomical energy can scarcely be said to have followed any special groove.

Dr. Winnecke suffered much from ill-health, which accounts for the fact that of late years his name has not been much before the astronomical world. Shortly after the completion of the Strasburg Observatory his health completely broke down and the directorship passed into the hands of Dr. Schur.

THE VARIATION OF β LYRÆ.—This remarkable star has lately been occupying some attention. In the publication of the Italian Spectroscopic Society for July 1897, M. Tikhoff makes an investigation in the following manner. His data are the variations of wave-lengths of certain lines given in Belopolsky's well-known memoir on this star. He chooses a certain line, whose wave-length he takes as $448.175 \mu\mu$, on the assumption that the period of its variation is the same as that of the observed light variation, viz., $12^d 22^h$, and from the variations of wave-length of this he computes the velocity in the line of sight of the dark body from which this dark line is supposed to originate. Similarly, from Belopolsky's measures of the wave-length of the bright hydrogen line $486.16 \mu\mu$ he draws a curve of the variation of velocity with the time. This curve and that before mentioned are consistent with the hypothesis that the dark ray and the bright ray emanate respectively from two bodies which are moving about a common centre of gravity, the dark body being the larger in the ratio 225:1, and that at the time of principal minimum the larger component passes between the Earth and the smaller. We note this to record another contribution to the literature of this subject, but the variations of the spectrum observed by Lockyer, Sidgreaves, and others are still unexplained. In a recent number of the *Ast. Nach.* (3456) M. Pannekoek discusses the other peculiarity of the star, namely, its observed variation of light. Taking the observations from the time of Argelander to the present day, he divides them into two periods, and derives from each the following times for the different phenomena, measured from principal minimum:—

	First max.	Second min.	Second max.
1842-1870	$3^d.12$	$6^d.40$	$9^d.54$
1870-1895	$3^d.32$	$6^d.48$	$9^d.73$

THE COMPANIONS TO VEGA.—In the August number of the 'Astrophysical Journal,' Prof. Barnard announced the discovery of a faint star near Vega, not hitherto seen there. Measures with a temporary micrometer on the 40-inch telescope of the Yerkes

Observatory gave as its position with respect to the large star pos.-ang. = 312° , distance = $53''$. Mr. George Anderson, of the U.S. Naval Observatory, then called attention to the fact that in 1881 he noticed a small star very near Vega, which Prof. A. Hall measured, with the result pos.-ang. $292^\circ.9$, distance $51''.48$, and he thinks that the Yerkes observation is merely a re-observation of this star.

In a recent number of the 'Astrophysical Journal' (No. 414), Prof. Barnard gives the history of these companions. In 1864 Dr. Winnecke discovered a small star near Vega with the Pulkova 15-inch telescope, and this is the star which was observed by Mr. Anderson. The star observed by him in May last is quite a different object, for both stars were measured on that occasion, 1897 May 28:—

Winnecke	$288^\circ.9$	$53''$
Barnard	$312^\circ.0$	53

The new companion is said to be much fainter than Winnecke's, which is given in Prof. Hall's measures of double stars as 14.5. It may be mentioned that the better-known neighbour to Vega, known as Struve's companion, is of magnitude 10, and its position with reference to the primary is about $161^\circ 53''$.

THE CONSTELLATION URSA MAJOR.—Dr. Höfler has investigated the mean parallax of β , γ , δ , ϵ , and ζ Ursæ Major, and obtains the small value $\pi = 0''.0165 \pm 0''.0011$. This makes the system roughly 200 light-years distant, and the distance from β to ζ at least four million times the distance of the Earth from Sun, or 14 times the distance between our Sun and α Centauri. Also ϵ Ursæ Majoris is 40 times brighter than Sirius.

GIFTS TO ASTRONOMY.—Miss Alice Bache Gould, daughter of the late Dr. B. A. Gould, has honoured her father's memory by entrusting to the U.S. National Academy of Sciences a sum of 20,000 dollars, which is to be known as the Benjamin Apthorp Gould Fund. The income of this sum is to be administered by a Board consisting at present of Prof. Boss, Dr. Chandler, and Prof. Asaph Hall, who are to devote it to aiding the prosecution of researches in astronomy by assisting observers and investigators in such manner and in such sums as may be agreed upon by all three of the directors. The gift is international—that is, the money may be applied to help an astronomer of any nationality; and Miss Gould expresses a strong wish that astronomy of pre-

cision shall be preferred to work in astrophysics because of her father's personal preference for the first-named, and the money is to be applied to the actual expenses of an investigation rather than to the support of the investigator.

SIR W. A. MACKINNON, K.C.B., Honorary Surgeon to the Queen, and formerly Director-General of the Army Medical Department, who has lately died, after making various bequests, left the residue of his property, which amounts to about £16,000 after payment of duties, to the Royal Society at Burlington House, for the purpose of furthering national and physical science, including geology and astronomy, and for the furtherance of original research and investigation in pathology, by prizes and scholarships.

NEW VARIABLE STARS.—The following announcements of variability have been made in recent numbers of the *Ast. Nach.* by Dr. Thomas Anderson, of Edinburgh, the discoverer of Nova Aurigæ:—

	R.A.			Decl.	
	h	m	s	°	'
Anon.	19	31	10	+11	23
BD. +67°·1124	19	9	54	+67	2
BD. +30°·1329	6	37	50	+30	25

These places are for epoch 1855·0.

A QUEENSLAND OBSERVATORY.—A Reuter's telegram from Brisbane states that Mr. Wragge, the meteorologist, who established and worked the first observatory on Ben Nevis, and who is now meteorological observer of Queensland, has arrived on the summit of Mount Kosciusko, the highest mountain in Australia, for the purpose of establishing an observatory there.—*Daily Graphic*, Dec. 9.

DUNSINK OBSERVATORY.—The post of Director of the Dunsink Observatory, which carries with it the title of Astronomer Royal for Ireland, left vacant by the appointment of Dr. Rambaut to the post of Radcliffe Observer, has been filled by the appointment of Mr. Charles Jasper Joly, M.A., Fellow of Trinity College, Dublin. Mr. Joly obtained a science scholarship at Trinity College, Dublin, in 1885, and senior moderatorship and studentship in mathematics and experimental physics in 1886, in which year he took his B.A. degree. He was elected Fellow of Trinity College in 1894. Mr. Joly has read several papers before the Royal Irish Academy, chiefly on subjects of pure mathematics. His work on Quaternions is well known.

STELLAR PARALLAXES.—The following are the values of the parallax of the ten first-magnitude stars in the Northern Hemisphere as determined at the Yale University Observatory (see p. 59):—

Star.	Parallax.	Star.	Parallax.
Aldebaran	+0"107	Regulus	+0"022
Capella	+0"081	Arcturus	+0"024
α Orionis	+0"023	Vega	+0"082
Procyon	+0"325	α Aquilæ	+0"231
Pollux	+0"056	α Cygni	-0"012

THE LONGITUDE OF MADRAS.—There has just been published the Report of the determination of the difference of longitude between Greenwich and Madras by the officers of the Indian Survey in 1895 (see Obs. vol. xviii. pp. 250, 330). We hope to give some account of the interesting details of this in a subsequent number. At present we are only able to give the result arrived at:—

		h	m	s
Difference of longitude :	Greenwich to Madras ..	5	20	59.113
"	" Greenwich to Potsdam..	0	52	15.929

The value of the arc Greenwich to Madras determined by the help of the British Transit of Venus observers in 1874 was $5^h 20^m 59^s.42$, and a determination by another chain of arcs, about some links of which, however, there is some doubt, came out as $5^h 20^m 59^s.65$.

THE TOTAL SOLAR ECLIPSE OF 1898, JANUARY 21.—Owing to the spread of the plague in India, and from other causes, the arrangement of the English observing parties has been somewhat altered. The approximate plan of campaign will be found on pages 46 and 47 of this number. The Astronomer Royal and Prof. Turner will be stationed at Sahagpoor.

WE call attention to the Partial Eclipse of the Moon which is predicted to happen on January 7. The phenomenon will be visible at Greenwich, and the time of middle of Eclipse is given as $12^h 35^m$ G.M.T., but as the portion of the Moon obscured will be small, the eclipse is of little interest.

Also to the occultation of η Tauri and stars in the neighbourhood of the Pleiades which will happen on Monday evening, January 3, between 7 and 10 o'clock.

M. HENRI DESLANDRES, of the Paris National Observatory, has been appointed "astronome titulaire" at the Meudon Observatory.

MR. LYNN asks to call attention to the omission, in the Table of Phenomena in the 'Nautical Almanac' for 1898, of a conjunction between the planets Mercury and Venus, which will take place on the 18th of April.

THE year 1897 marks the centenary of the marine chronometer as at present constructed, for in 1797 Thomas Earnshaw submitted his first chronometer for trial at the Greenwich Observatory.

MR. ERIC DOOLITTLE gives in the 'Astronomical Journal,' No. 416, the measures of a few important double stars made in 1897 with the 18-inch refractor of the Flower Observatory.

FROM AN OXFORD NOTE-BOOK.

It seems only a week or two ago that we came back from the Eclipse Expedition to Japan, and yet here we are starting out again; or at least here *I* am. Others have started at various times, days or even weeks ago, and small blame to them for getting off soon and seeing as much of India as they could. On these expeditions the best time for sight-seeing is before and not after the great event, for if the eclipse be totally cloudy one cannot enjoy life properly just afterwards, and if it be successfully observed, sight-seeing is an anticlimax. (Of matters other than weather which may render an expedition fruitless it is not good to speak.) However, even the rearguard will probably have a few days to spare for seeing India before the serious work of preparation for January 22, especially as there will be good weather, by all accounts, and consequently the preparations can be made quickly.

THERE are some difficulties about this month's "Notes." I am at this moment (Dec. 15^d 4^h G.M.T.) in the P. and O. Express from Calais to Marseilles, there to join the good steamer 'Bal-laarat' early to-morrow morning. But it has just been borne in on me from an inspection of the P. and O. Handbook that copy for the January number must be posted from Marseilles. It is, of course, rather late to make this discovery, and shows a lamentable want of forethought; but those who have gone through the experience of packing up for an expedition in the midst of other duties will have some sympathy for the delinquency. However, that is the situation—the expectations of the Editors must be satisfied before I seek my downy couch to-night (and I may not

find much downiness in the couch if this railway-seat I am sitting on is it).

BUT what to write about? The expedition has not yet proceeded far enough to afford any really exciting or amusing events. It left Victoria at 11^h this morning, with kindly wishes from one or two friends assembled. One of them wanted to buy some interesting reading for the voyage and selected 'Whitaker's Almanac' for 1898; but as the charges for heavy baggage were rather high, this kind offer was declined. We had a fine channel-passage—a bit choppy perhaps, and one or two people got drenched with spray and looked comical enough at the time; but we—I mean they—bore it so well that I don't think they ought to be made fun of in print. Now we are inside this train which is to deposit us at Marseilles, and I don't see what is to happen worth recording before evening. It seems clear that with these few words of explanation, I must leave the Eclipse Expedition and go to other topics. Fortunately I did bring with me the small accumulation of scraps from the drawer which supplements the "Note-Book."

THE first scrap is the 'Times' account of the Royal Society Anniversary—rather a big scrap which does not help much. The 'Times' generally gives all the dull speeches at full length and only a word or two of the interesting ones. So we get the Duke of Devonshire filling two-thirds of a column, and Prof. Forsyth (replying for the toast of the year, viz. the Medallists) represented by a dozen lines. Perhaps it is a little hard on the former speech to call it dull, for it was well delivered, and the speaker held the attention of his audience, but he managed to say absolutely nothing at all in a rather nice way. Once he nearly said something—it sounded as though the Government were favourable to a Teaching University for London, but the cheers which followed showed the noble speaker that he had gone too far, and he promptly corrected himself: "I am not here to hold out any sanguine hope," &c. So the nett result was—nothing. The replier for the medallists, on the other hand, starts with something to talk about, and always talks in an interesting way, and so he only gets a few lines in the 'Times.' I wish I could rectify the omission, but can only remember one graceful little quip. Professor Forsyth modestly expressed surprise that the Council had awarded the Medal to so young a man as himself, and after a moment's pause said, deprecatingly, "I am not here to justify the Council—still less do I blame them." This is rather neat and may be useful to others on a similar emergency. Perhaps I may add that the thing which made most impression on me during the day was the announcement in the afternoon speech of the President that by mixing glycerine

with vaccine, the "adventitious microbes" in the latter were killed: "a discovery which removes the last rational objection to vaccination."

THE next item is a pair of small paragraphs from different papers. The names of five gentlemen are mentioned, and I hope I shall not get into trouble with any of them. The point to be illustrated is a journalistic one merely, the transmutation of one paragraph into another in the space of a few hours. The first clipping is from the 'Daily Telegraph' of Dec. 9, and the second from the 'St. James's Gazette' of Dec. 10; and the question is, had the writer of the second anything more than the first paragraph to build upon? It is, perhaps, dangerous to answer, but one may ask the question.

Science has now claimed the services of the cinematograph. The Rev. J. M. Bacon, one of the members of the British Astronomical Association, who is going out to India to observe the eclipse of the Sun next month, takes with him a powerful cinematograph camera, which will produce five or six photographs a second. His instrument, if only it works satisfactorily, will give the most complete series of simulacra ever produced of the corona surrounding the Sun, and its evidence should help to settle the question whether changes take in the appearance of the corona during the brief moments of eclipse.

Among all the scientific instruments with unintelligible names which Sir Norman Lockyer and the Astronomer Royal are taking out to-day to India, there is one that will appeal more forcibly than all the rest to cultured London audiences. Need we say we refer to the cinematograph? It should be explained that "living pictures" of Dr. Common and Professor Turner at their work will not be exhibited next season either at the Alhambra or the Westminster Aquarium. But Phœbus himself, in the very process of eclipse, will be photographed for reproduction by the remnants of his own light—or so we gather. There seem no limits to the possibilities of this entertaining invention.

NEXT there is an extract from the 'Cambridge Review' about Sir Robert Ball. But I don't feel quite sure that I dare ——. Sir Robert looks strong and active, and I have never seen the shillelagh in the hands of an angry man yet. We ought to be a little careful what we say in print, or even reprint. But the word is being passed for dinner. . . . And a very fair dinner too for train-fare: they really manage these things very well in France*. Well! after all, what is a shillelagh anyway? It is only a stick. And then I am leaving the country for a spell, and

* Anecdotal reminiscence of dinner:—The chef brings in a dish of *poulet rôti*, consisting of a nice-looking *undissected* chicken in the centre, with a lot of little bits of some other fowl arranged round it; and remarks genially to young and robust Englishman, as he helps him to one or two small bits: "Salade will come in a meenit, Sare!"

Y. & R. E. (looking at his plate with disgust), "Yes! but I don't want 'sal-add,' I want something to eat!"

I must get these notes finished to-night, and a real printed extract saves such a lot of writing. So here goes :—

We ought to be proud of Sir Robert Ball. In the account of an interview with a lecture agent, in the 'Daily News,' the interviewer asked: "Who are the most popular lecturers to-day?" "The most popular is undoubtedly Sir Robert Ball, the late Astronomer Royal of Ireland, and now Lowndean Professor of Astronomy at Cambridge. He can book up just so many engagements as he cares to undertake, and his manner is so attractive and his lectures so interesting that people always want to hear him again. They go away from Sir Robert Ball's lectures feeling well satisfied with themselves, for have they not been studying science, and at the same time have obtained as much recreation and amusement as though they had been to a comedy?" That is, we suppose, the crowning instance of the combination of sweetness and light.

THERE was an astronomical examination held lately, and the candidates were asked about the German and English forms of equatorial. One of the depositions was as follows :—

In the German form there is only one support, viz., at the floor. The English form has the advantage in that it is more stable, and, further, the telescope can be rotated round as often as we like.

The last phrase reminds one of Dr. Routh's story of the examiner in arithmetic, who, wishing to test the candidates' insight into the principles of division, asked: "How many times can 19 be subtracted from a million?" One genius wrote down a million, subtracted 19, and drew a line under the result. He again wrote down a million, subtracted 19, and got the same result; again wrote down a million, and again performed the same operation, and so filled a neatly-written page, putting as a footnote: "N.B.—I can do this as often as you like."

NOW I don't think there is anything left but Dr. Johnstone Stoney's paper "Of Atmospheres upon Planets and Satellites"*. He gave me a copy of it with his own hands, but I am going to criticize it adversely with some emphasis, because it is a conspicuous example of faulty numerical work, against which a desultory war has been waged for some time in these Notes. Dr. Stoney made the valuable suggestion some 30 years ago that the lighter constituents of a planet's atmosphere tend to escape, the tendency being greater for planets of small mass when the restraining power of gravity is consequently small; and he explained the non-existence of atmosphere on the Moon on these lines. (Mr. Percival Lowell has made good use of the idea in

* Trans. of R. Dublin Soc. vol. vi. series ii. no. xiii. (Williams and Norgate).

his book on Mars.) The present paper is an attempt to give numerical values to the facts: there is nothing new in the paper but the arithmetic. The best values of the dimensions of each planet are considered and numerical deductions made accordingly. Now surely we may expect here that the arithmetic shall be done on sound principles? It is not incidental, but the main part of the paper, and so we are free to examine it rather closely. Here, then, is an equation given indirectly on p. 313:—

$$v'^2 = 2aR^2/(R+h).$$

[The equation is given in several pieces according to Dr. Stoney's peculiar methods, which need not be here followed.]

Now herein h is the height of the atmosphere, only roughly known, and assumed to be 200 kilometres; i. e. only *one* significant figure is assumed. Clearly the other data need only be so taken, and the quæsitum can only be found very approximately. It is useless to cover paper with small corrections. But what does the author do? He takes four figures for R , the Earth's equatorial radius (6378 km.), four figures for a , which is gravity on the equator (978·1), and he *corrects this* by the quantity 3·4 for the rotation of the Earth; he determines v' (the minimum speed of projection which would carry a molecule clear away from the Earth) to *five* figures, viz.:

$$v' = 11·015 \text{ km./sec.,}$$

and finally, after another correction which brings it to 10·537, he ventures to cut off the last two figures "*if a strong west wind is blowing at the top of the atmosphere, which must sometimes happen!!*" Who but an Irishman could have associated the tenuity of atmosphere worthy of being called "the top" with a "strong west wind"? The idea is beautiful. I can almost forgive him his rows of figures and formulæ, and his fifteen chapters and an Introduction, all contained in 20 pages, and all of which I am spared reading by seeing this early example of how he gets his results.

FIVE minutes to ten, and a beautiful night. There is another "eclipse" aboard the train, and he has just come in to tell me how bright Sirius is. Also we have made out that perhaps there will be opportunity to send letters later than I thought. However, there ought to be enough copy by now, whether any more follows or not; so the couch, if not downy, will be at least a virtuous one. . . . As an absolute fact the man who, at this point, undertook to make up the bed has just been to tell me that it has *broken down*. This is a new sort of "downiness." Can it be the strain of supporting these weighty reflections during the afternoon and evening that brought about the catastrophe?

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

FEBRUARY, 1898.

No. 263.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, January 14, 1898.

Sir R. S. BALL, LL.D., F.R.S., *President*, in the Chair.

Acting Secretaries: E. B. KNOBEL and F. W. DYSON, M.A.

THE Minutes of the previous Meeting were read and confirmed.

Mr. Dyson. Since the last Meeting 85 presents of books and papers have been received. The first which calls for special mention is Vol. 13 of the collected Mathematical Papers of Prof. Cayley. This completes the series of Professor Cayley's papers. There are also two volumes from the Cape of Good Hope Observatory which give the determination of the solar parallax from heliometer observations of the planet Sappho in 1888-9; and we have also received from the Cape of Good Hope an appendix to a volume of the Cape observations, but published separately, which consists of the tables devised by Mr. Finlay for computing star-corrections; and besides these we have received the first volume of the 'Durchmusterung' made from photographs taken at the Cape.

Dr. Rambaut proposed, and *Dr. Johnstone Stoney* seconded, that Mr. Inwards, Mr. Levander, and Mr. Crommelin be appointed Auditors of the Society's accounts for the past year.

Mr. Knobel then read papers by *Mr. S. W. Burnham* on "The Orbit of O Σ 400" and on "The Double Star ζ Boötis (Σ 1865)," and one by *Mr. R. T. A. Innes* on "The Ternary System Lac. 7215 (h 4935)."

Mr. Lewis. I do not know that I can say anything of much interest on these subjects. I always feel, when a paper of this kind is read, that it is somewhat analogous to reading the result of an ordinary catalogue, because it deals with a mass of figures which one ought to sit down quietly and look at. I fancy they are rather uninteresting to the general body of Fellows. I speak in a dual capacity, because I sometimes dabble in making orbits and

I am also a double-star observer. I therefore get twice the amount of excitement out of them. I get excitement as a double-star observer because I like to see observations taken in hand by computers and made use of. As a computer I like to see how the orbits are handled by other people. There is one point about the star Ω 400 which interests me. I should like to know how Mr. Burnham treated Otto Struve's observations. It has always been a doubtful point with me in dealing with these to know how to treat them. To Otto Struve's observations of this particular star there would be a correction of 8 or 9 degrees in angle. What is one to do? Are we to take the original observations or the same after correction? Struve made a large number of observations for personal equation, and if they are any good they ought to be made use of. I should like to know how Mr. Burnham has treated them. I did ask him some years ago, but he did not answer. I suppose he has taken the original observation. I daresay many Members may wonder why one computer two years ago should get a period of 170 years, whereas Mr. Burnham now gets a period of about 80 years. The fact, I think, lies in the difference of methods. Mr. Gore no doubt took a few observations at one period and a few at another, and worked them out by the method of least squares. The observations of double stars, I am afraid, are not sufficiently accurate for this method. Mr. Burnham employs a graphic method, and no doubt his results are much more to be relied on. I believe that, if anything, the period is really shorter.—As regards Struve's star 1865. Last year I looked at it in April and in June with the 28-inch at Greenwich. In April I could not find any elongation whatever, but in June I thought it elongated at an angle of 258° . That would seem to show that the nearest distance was either last year or this year, so that Mr. Burnham is not far out there; but, as I said, in order to really grasp the nature of these papers, one wants to sit down quietly and look at them.—The third paper is important in a way. The star itself has received a great deal of attention from computers and double-star observers, but it is important as showing that people in the Southern hemisphere have, at last, woke up to their responsibility. Double stars in the Southern hemisphere have been entirely neglected, and I am glad to see that Mr. Innes and Dr. See have settled down to work.

Dr. Rambaut. I should like to ask Mr. Knobel whether there is any information in Mr. Burnham's paper as to how the apparent orbit is arrived at. I think that Mr. Burnham gives the distance equal weight with the position-angles in the orbits, and seems to have abandoned the method devised by Sir John Herschel for determining the shape of the orbit from the position-angles alone. In looking at the diagram it seems to me that the apparent orbit which he has laid down is not one which a computer at first sight would have selected, and I think it would be interesting to know by what considerations he was guided.

Mr. Knobel. Mr. Burnham gives no further information than I have already read.

Mr. Lewis. I know Mr. Burnham always uses a graphical method. That is to say, he will plot out both angle and distance, and through the points thus obtained he draws a line or a curve. In a case of this sort, where I suppose for the first forty years the angle did not change more than a degree, the distances would be of far greater value than the angles. Double-star observers, I think, do not profess to go so close as minutes in an angle. In Sir John Herschel's time, when he devised this method, micrometers were not in such an advanced state as they are now. I should certainly give more prominence to distance than to angle, especially where the stars are of different magnitude. In measuring a small star and a large one, it is necessary to judge the centre of each; but some observers do not do anything of the sort, but unconsciously take the tangent to both. The width of the wire in the Lick telescope I suppose does not exceed that of the 28-inch at Greenwich, which is less than one-tenth of a second of arc, so it does not leave much room for error in distance-measures in this respect.

Mr. Knobel read extracts from a paper by *Dr. Gill* on his determination of the parallax of Sirius made from heliometer observations. The resulting parallax was $0''.37$; and *Dr. Gill* said that by this method of measurement it was possible to determine parallaxes so small as $0''.02$ with some confidence.

Mr. Dyson. One cannot help being struck by the wonderful accuracy shown by the very small figures to which *Dr. Gill* can go. The observations were made, I presume, with the same heliometer as that used in determining the solar parallax. One thing I noticed in reading this volume which illustrates the methods *Dr. Gill* employs to obtain such accurate results. He spent two hours a day for nine months in determining the division errors of the heliometer scales. One is sometimes asked what reliance is to be placed on results dealing with such small quantities as hundredths of seconds of arc; and it may be certainly said that they can only be obtained when infinite care and pains is devoted to them. I should like to ask what were the distances of the comparison stars.

Mr. Knobel. The distance from Sirius of the star called γ was 4310 seconds, and of δ was 4536 seconds. In the first case the position-angle was 279° and 101° in the second.

The President. This paper of *Dr. Gill's* is certainly remarkable. It is astonishing that distances exceeding 4000 seconds can be measured with a probable error so small, and that a parallax of only one-fiftieth of a second can be detected. But, knowing *Dr. Gill's* care and skill, we can readily accept these facts.

Dr. Johnstone Stoney made a communication on "Problems presented by the Leonids and how to deal with them." After giving an extremely lucid and interesting history of the Leonid swarm from

the time of its earliest observation until the present, and of the remarkable discoveries made in connection with the last visit to the Earth of the main swarm in 1866 and 1867, Dr. Stoney stated that the points to which astronomers should now devote their immediate attention were:—

1. To prepare with the utmost forethought for observations upon the parts of the main stream through which the Earth will pass in 1899 and 1900, and perhaps in either 1898 or 1901; and especially for accurate determinations of the radiant-points, both by eye-observations and photography, on each of these occasions, and separately in each quarter of an hour while the shower lasts.

2. To make full and careful observations upon Tempel's Comet, which traverses an orbit nearly coincident with that of the meteors.

3. To compute, before next November, the perturbations which the orbit as determined by Adams of the part of the swarm through which the Earth passed in 1866 has experienced, in the years which have elapsed since that time, from the attraction of the planets Jupiter, Saturn, and Uranus; so as to be able to predict the hour as well as the day when the Earth will next pass through that part of the stream.

Capt. Steele then gave some views of his own on the physical cause of meteors, but the President suggested that they were not sufficiently astronomical.

Prof. A. S. Herschel said that Dr. Stoney's paper embraced such a wide field of the past and of hoped-for future discoveries about the Leonids, that it was difficult to fix on the points of the paper which seemed to be of the most important interest. But one or two questions had occurred to him to ask while the paper was being read, on which he would much like to be further informed by Dr. Stoney. The encounter of the meteor-cloud with Uranus in A.D. 126 was figured in the map which had been shown as one which converted a direct-moving parabolic into a retrograde elliptic orbit by a passage of the meteor-cloud close in front of Uranus. Without doubt this figure (which illustrated M. Flammarion's paper in the French Astronomical Society's 'Bulletin' of last November, on the "November Meteors") was a correctly typical one of the nature of the encounter, which must really have occurred; but as to the amount of deflection, and as to the diminution of orbit-speed originally produced by the planet Uranus, as it touched a question about the probable original compactness of the comet-and-meteor-cloud, he would like to ask if the orbit shown as the comet's probable original path before disturbance by the planet was an exactly computed result from given data, or whether, by any possibility, before encountering Uranus, the comet may have been moving in some other parabolic or perhaps in some elliptic path? Exact observations of the comet at its approaching return, and an accurate determination of its

orbit, will perhaps afford the means of determining this point conclusively.

Another point of interest connected with the subject of the paper was the date of maximum of the shower of Leonids at its return in last November. Although on the fine night of November 13-14 hardly more meteors were seen in England and on the Continent than on any ordinary cloudless moonlight night, so as wholly to disappoint all observers watching for the shower in Europe on that night, yet in the four or five hours immediately following their unsuccessful watch, ninety meteors, nearly all Leonids, were counted on November 13-14 by the observers of the Harvard College Observatory at Cambridge, Mass., and several Leonids, one of great length and brightness, were noted by Professor O. Stone at Richmond, in Virginia. Although, also, the next night's sky was so widely cloud-spread as generally to veil the progress of the shower both in Europe and America, yet a distinctly bright shower of Leonids was certainly seen in England and Scotland, at Loughborough, Derby, and Dumfries, from between 4^h and 5^h A.M. until daybreak on November 15, which, with a clear sky and more favouring hours of darkness at the same time in California, was seen through the night there so well at the Lowe Observatory at Echo Mountain, that Professor Lewis with promptly announced its apparition thus to Mr. Denning:—

The Leonids made their appearance on the morning of November 15th, ninety-seven having been seen by one observer." A letter from Dr. A. A. Nyland, at Utrecht, to Mr. Denning stated that on the following night of November 15-16, in 3½ hours ending at 4^h 45^m A.M., among forty meteors noticed thirty-two Leonids were recorded, six of them as bright as Jupiter and first mag. stars, and four as bright as Venus, and fifteen of them leaving streaks visible, even in the moonlight, in some cases for 3-7 seconds; the radiant-point, with a secondary adjoining one, being well defined at $152^{\circ} + 24^{\circ}$. Thus distinct views of bright Leonid displays were obtained successfully last November on each of the mornings of November 14th, 15th, and 16th. No full view seems, however, yet to have been obtained of a middle stream among these scattered showers, or lateral appendages; and it would be interesting to hear if any reports of observations of the shower have perhaps reached Dr. Stoney which might help to indicate on what date of November last the Earth's encounter with the main meteor-stream took place. But it is perhaps very doubtful if any part of the stream can yet be properly described so at present, when the densest portion (as M. Flammarion has shown in an effective diagram in the above-mentioned number of the French Astronomical Society's 'Bulletin') was still as far off in November last as halfway between the orbits of Jupiter and Saturn, and when it will even in November next be nearly as far distant from the Sun as Jupiter is, though only twelve months

later, in November of next year, 1899, it will encounter the Earth's orbit!

Dr. Johnstone Stoney. In answer to Prof. Herschel's first question, I may point out that the curve represents the orbit traversed by the meteors before they encountered the planet. Prof. Herschel has hardly made allowance for the exigencies of drawing. We certainly know that the meteors could not have pursued an orbit which brought them close to the Sun, otherwise they would not have been able to hold together. Professor Newton, in conversation with me some years ago, expressed his opinion that it would be almost impossible for the meteors to have kept together as a cluster even as far as the orbit of Uranus. In consequence of that conversation I computed what the mass and size of the group should be in order that they might be able to hold together, and I satisfied myself that from the enormous length and breadth and depth of this swarm, there may have been enough of bulk and mass in the existing swarm to have formed such a group, as would have remained a compact group up to the time of encountering Uranus; but it could not have been a compact group if it had had an elliptic orbit bringing it much nearer to the Sun. The diagram was drawn in 1869. With reference to the observations that were made last year, I have seen no record of observations that give me the impression that the real main swarm had yet arrived. Of course it is to be expected that there will be an increase in the number of sporadic meteors as the Earth comes near to the main swarm. Last November we were certainly not far from the front of the main swarm, although its actual front may not have reached the Earth. There is strong evidence that the meteors observed on 13th and 15th Nov. were not part of the main swarm.

The President. We are very much obliged to Dr. Stoney for his paper. I have had an advantage which I think no one else in this room has enjoyed, and that is, I have had the privilege of sitting at the feet of Dr. Stoney on the subject of shooting-stars ever since the last shower in 1866. I hope we shall have the opportunity of profiting by Dr. Stoney's study of so many years when the shower does come.

Dr. Stoney then exhibited on the screen a photograph of the Sun which he said was intended to illustrate how the meteors may have first arisen. The whole of the Sun is evidently in a state of extremely violent agitation. The motions which are going on within the Sun must be something enormous. The most probable conjecture that could be made as to the origin of meteors is that they come from the Sun, except that some might come from the Moon. Most metallic meteors have probably had a solar or stellar origin, while lunar meteors are probably most of them of a stony character.

Mr. Newbegin then showed photographs of the Sun taken with his 4½-inch telescope on 1897 January 4, and 1897 July 1.

Mr. Crommelin said his ephemeris for Physical Observations of Jupiter was in continuation of those which Mr. Marth had con-

tributed for so many years. He had used the same position of Jupiter's axis and the same periods of rotation and the same zero meridians that Mr. Marth had employed. He had not as yet made out a table of the time at which the zero meridians of the two adopted systems crossed the centre of the disc. It appeared to him that this was a datum that was not very often required, and when the need did arise the quantity sought could be deduced in a few moments from the longitude of the central meridian at noon which was given in the ephemeris. If, however, any considerable number of those who used the ephemeris expressed a desire for such a table, he would be delighted to compute it.

The following papers were announced and partly read:—

R. T. A. Innes. "The Ternary System Lac. 7215 = h 4935."

S. W. Burnham. "The Double Star ζ Boötis = Σ 1865."

S. W. Burnham. "The Orbit of O Σ 400."

F. L. O. Wadsworth. "Note on the Result concerning Diffraction Phenomena recently criticised by Mr. Newall."

Royal Observatory, Greenwich. "Observations of Occultation of Stars by the Moon, and of Phenomena of Jupiter's Satellites made in the year 1897."

Radcliffe Observatory, Oxford. "Occultation of the Pleiades by the Moon on 1897 July 3 and 1898 Jan. 3."

A. C. D. Crommelin. "Ephemeris for Physical Observations of Jupiter, 1898."

David Gill. "On the Parallax of Sirius and α Gruis."

G. Johnstone Stoney. "On Problems presented by the Leonids and how to deal with them."

The following gentlemen were elected Fellows of the Society:—

Capt. E. J. Griffin, Lieut. R.N.R., Commander Union S.S. 'Moor,' Southampton.

J. Nevil Maskelyne, 88 Trinity Road, Upper Tooting, S.W.

Ambrose Swasey, Cleveland, Ohio, U.S.A.

John Vaughan, Sub-Lieut. R.N.R., Commander China Navigation Co., Shanghai, 42 Aubert Park, Highbury, N.

T. E. Young, B.A., President Inst. of Actuaries, 108 Evering Road, Stoke Newington, N.

The following Candidates were proposed for election as Fellows of the Society:—

Eric Doolittle, Assistant, Flower Observatory, University of Pennsylvania, Philadelphia, U.S.A. (proposed by T. J. J. See).

Alfred Taylor, Messrs. T. Cooke and Sons, Buckingham Works, York (proposed by R. Wigglesworth).

Rev. Kingsbury Jameson, M.A., Highfield, Hendon (proposed by A. H. Fison).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE Second ordinary meeting of the current Session of the British Astronomical Association was held on Wednesday, December 29, at Sion College, *Mr. N. E. Green*, President, in the Chair.

The election of 17 new members was confirmed and the names of 9 candidates for membership were read and suspended.

Mr. Schooling read a paper by *Mr. Fritz Hopman* on "Dark Meteors." The object of the paper was to claim for *Mr. du Cellié Muller* the honour of being the first to discover the existence of dark Meteors. On the 4th April, 1892, *Mr. Muller* was observing the Moon with a Molteni telescope when he observed little black specks moving with great rapidity before the disc of the Moon. He again observed the same phenomena on the 2nd December following, and came to the conclusion that they were meteors moving outside our atmosphere and consequently not incandescent.

Mr. Muller's discovery had been received with a considerable amount of scepticism. *Prof. Krueger*, of Kiel, was of opinion that *Mr. Muller* had seen birds passing before the Moon, others had suggested that the black specks were plant seeds, and others again that the phenomenon was caused by particles of dust in the eye of the observer. *Mr. Hopman* claimed that subsequent observations had proved that neither of these suggestions was in conformity with the truth, and that the identity of the dark meteors had been established. The paper went on to give the results of *Mr. Muller's* observations, carried on in co-operation with *Mr. A. J. Gouka*, *Junr.*, and *Mr. G. J. van Dyk*. The shape of the larger bodies observed, one or two of which had appeared about as big as the lunar crater Tycho, was always circular, while their apparent velocity was different for different meteors.

The President said he had often seen birds crossing the face of the Moon and had been able to distinguish their shape clearly.

Mr. Chambers was afraid he must include himself among the sceptics mentioned in the paper. He would have liked a good deal more information as to the kind of telescope used, the atmospheric conditions and general surroundings, the time of day or night &c., but taking the paper as it stood he was bound to say that he did not think the writer had made out his case.

Mr. Holmes remarked that they were not told what was the age of the Moon at the time of the observations. How was it that the Sun did not shine on the meteors at the same time as on the Moon and render them bright? Every observer was familiar with birds and bats crossing the field of the telescope, and when out of focus they looked more or less round bodies.

Mr. Kennedy said that if these bodies were outside the Earth's atmosphere and appeared as large as Tycho, they must be enormous.

The President pointed out that as they had no means of judging,

in the case of such objects, what their distance was, their size was purely conjectural.

Mr. S. H. R. Salmon contributed a paper on observations of Comet Perrine made during October last. On the 29th October, at 7^h 30^m, the comet was easily picked up in the 3½-in. finder, and later it was observed to pass over a 12th magnitude star. At 10^h 0^m, definition being perfect, the head could be seen to glitter as if it contained a star. On Oct. 30, 6^h 30^m, the comet was found by sweeping with 12½ in., not being visible in the finder. By Nov. 19 the object had passed beyond the reach of Mr. Salmon's instrument.

Mr. Chambers being called upon by the President to give an account of his visit to the Brussels Exhibition, said that, while Meteorology was very fully and satisfactorily represented at the Exhibition, there was a meagre number of exhibits connected with the twin science of Astronomy. With respect to instruments, there was not much worth seeing and very little that was new. The only instrument that was worth anything was one of Sir Howard Grubb's, and this, although not a large one, was a worthy representative of United Kingdom art. There were some good lunar photographs from the Paris Observatory by Loewy, and from Prague by Weinek. The most original instrument he saw was a scintillometer or twinkling measurer.

Referring to the Brussels, or rather the Uccle Observatory, the speaker said that he had spent a very pleasant hour going over it, but that he had chiefly learnt from his visit was how not to do it. It was a magnificent building and had cost £100,000, but it was on far too colossal a scale for practical work, and would require another £100,000 to properly complete it and equip it with instruments capable of doing modern work.

The President then read a communication, which he had received during the Meeting, from *M. Antoniadi*, the director of the Mars Section. *M. Antoniadi* stated that he had discovered that the geminations of the Martian Canal and Lake systems had no objective existence, as he had succeeded in reproducing on paper almost all the phenomena of these doublings exactly as seen and described by Schiaparelli. The effect of this would be very great, for when it was shown that the linear markings of Mars were not really doubled, the planet would once again enter into the sphere of their intellectual grasp. *M. Antoniadi* concluded his letter by a promise to submit to the Association his detailed trials of artificial gemination very shortly.

Mr. Newbegin then showed with the aid of the lantern several photographs of sun-spots taken between May 2 and Sept. 9 last year; and *Mr. Maw* exhibited a number of slides illustrating the Coronas of 11 different eclipses. These had been prepared by Captain E. H. Hills from photographs in the possession of the Royal Astronomical Society, all being reduced to the same scale.

During the evening the *Rev. Arthur East* explained the process

by which he produced artificial sun-spots by means of a pan of paper pulp and water, with a lighted spirit-lamp underneath (as fully described at the previous meeting of the Association); with the aid of the lantern he showed several illustrations of the results of his experiments.

Mr. Schooling announced that the library had been moved to Sion College, and that books could now be obtained on application to Mr. Levander.

ROYAL METEOROLOGICAL SOCIETY.

THE Annual Meeting of this Society was held on Wednesday, January 19, at the Institution of Civil Engineers, *Mr. E. Mawley, F.R.H.S.*, President in the Chair.

The Secretary read the Report of the Council for the year 1897, showing that there had been an increase in the number of Fellows and that the finances were satisfactory.

The President (*Mr. Edward Mawley*) then gave an address on "Weather Influences on Farm and Garden Crops," in which he pointed out the intimate connection between Meteorology, Agriculture, and Horticulture. He explained the special characteristics of the climate of the British Isles as regards temperature, rainfall, &c. Of all the influences brought to bear on vegetable life by the atmosphere, he considered temperature to be the most powerful and far-reaching, and only second to this came rainfall. The leading effects of snow, wind, and sunshine, as well as of prolonged droughts, severe frosts, and persistent rains, were also described. He then dealt with the influence of different important weather changes on such farm-crops as wheat, roots, grass, &c., as well as on fruit-trees, vegetables, and flowering plants in the garden. In his concluding remarks he called attention to the great want of experimental farms in conjunction with meteorological stations being established in this and other countries in Europe; for it was only by the examination of meteorological observations, together with weekly records of the extent and character of the growth made by our leading crops, that the close connection existing between weather changes and their influences on such crops could be clearly traced.

Mr. F. C. Bayard, LL.M., was elected President for the year.

The Total Solar Eclipse.

THE inference drawn from *Mr. Eliot's* weather statistics (*Mon. Not. R.A.S.*, March 1897), that clouds would not prevail in India along the line of totality during the Total Solar Eclipse of Jan. 22 (civil day), appears to have been fully justified. So far as we have at present heard, all the observing parties were able to make successful observations. We put on record here the stations, the

names of the chief observers of the expeditions, the instruments employed, and results as far as at present known, beginning at the west coast.

VIZIADRUG.—*Sir J. Norman Lockyer, Mr. A. Fowler, and Dr. Lockyer.*

A 6-inch prismatic camera, with two prisms of 45° to give large dispersion. (Fowler.)

A 9-inch prismatic camera, never before used in an eclipse. (Dr. Lockyer.)

A grating spectroscope to observe the corona visually. (Sir J. N. Lockyer.)

Two kinematographs. (Marquess of Graham.)

A coronagraph with coelostat. (Crew of H.M.S. 'Melpomene'.)

An integrating spectroscope.

It appears that all these instruments were successfully employed except the last.

JEJUB.—*Prof. Naegamvala, with a party from the Royal College of Science, Poona.*

These observers are said to have been entirely successful.

TALNI.—*Mr. & Mrs. E. W. Maunder, Mr. Thwaites, Mr. Evershed.*

A double-tube photoheliograph mounted equatorially. One tube carrying an objective of $2\frac{1}{2}$ inches aperture, with a magnifier which gives an image of the Sun of $\frac{1}{4}$ -inch diameter, the other tube furnished with a smaller object-glass, which gives a disc one-tenth of an inch in diameter. (Mrs. Maunder.)

An opera-glass with direct-vision prism on one eyepiece, to be used in the endeavour to ascertain the distribution of that part of the coronal light which is given by the line 1474 K. (Mr. Maunder.)

A Cooke equatorial with $4\frac{1}{2}$ -inch object-glass, and provided with camera. The image of the Sun would be 0.67 inch in diameter, and the plates used would be large enough to contain a corona of $\frac{1}{2}$ solar diameters on either side. (Mr. Thwaites.)

A prismatic camera, with two 60° prisms, to be used with a heliostat to photograph the "flash" spectrum. A slit spectrograph to be used with the same heliostat. (Mr. Evershed.)

This party was quite successful.

PULGAON.—*Mr. H. F. Newall and Capt. E. H. Hills, R.E.*

A twin telescope, one tube carrying an achromatic lens of 3.85 inches aperture and 62 inches focal length, which gives an image of the Sun about $\frac{5}{8}$ -inch diameter. The other tube carries a lens of $4\frac{1}{2}$ -inch aperture, which in combination with a negative lens gives an image of the Sun's disc of about $1\frac{1}{8}$ inches in diameter. The plates to be used for these are $6\frac{1}{4} \times 6\frac{1}{4}$ inches, and the telescope is to be pointed to a 16-inch mirror mounted as a coelostat.

A slit spectroscope having O.G. of $4\frac{1}{2}$ inches aperture and two prisms of 60° angle, base $4\frac{1}{2}$ inches, height $2\frac{1}{2}$ inches.

A slit spectroscope having O.G. of 5 inches aperture and four prisms of 60° angle, base $3\frac{1}{2}$ inches, height $2\frac{1}{2}$ inches.

One of these spectroscopes was used with the slit tangential to the Sun's limb, the other with the slit radial.

The spectroscopes, which were in Capt. Hills's special charge, were fed by a heliostat of ordinary pattern. We have no details of Mr. Newall's spectroscopic instrument. The telegrams report that all the observers were successful.

NEAR NAGPUR.—*Dr. Copeland.*

A telescope, which has an object-glass of 40-feet focal length, to be placed in a horizontal position, with a mirror fixed in position so as to reflect the Sun into the telescope at time of eclipse. Plates 18 inches square will be moved by clockwork on the plate-holder to follow the Sun.

A small ultra-violet prismatic camera of quartz and Iceland spar.

A whole-plate camera mounted equatorially, which will be exposed on the eclipsed Sun during the whole of totality.

SOHAGPOOR.—*The Astronomer Royal and Prof. Turner.*

The Thompson photoheliograph. Object-glass 9 inches aperture and of 8 feet 6 inches focal length. A magnifier is placed within the focus so as to give an image of the Sun 3 inches in diameter. The camera is of a size to take 12×10 inch plates. (Astronomer Royal.)

A double-tube telescope similar to that in charge of the observers at Pulgaon. The tubes of these twin telescopes, both of which were used at the eclipse of 1893 April, consist of a wooden box of 14×7 -inch section, divided along its length so as to form two tubes of 7×7 -inch section. The lenses and plates of each are described above. (Prof. Turner.)

A polariscope apparatus mounted on the double camera, consisting of an ordinary slit spectroscope, with an Iceland spar double-image prism in place of the ordinary prism. This instrument was used with the intention of taking two photographs of the corona, one with each of the polarized rays. (Prof. Turner.)

These instruments were all pointed to coelostats having 16-inch plane mirrors. Observations were made with all the telescopes*.

Besides the above there was a party of members of the British Astronomical Association at Buxar, near Benares, whose principal instrument appears to have been a kinematograph. The Lick observers under Prof. Campbell at Jeur are said to have made successful observations.

* A telegram received from Prof. Turner just as we go to press states that some photographs taken by the observers at Pulgaon, Nagpur, and Sohagpoor have been developed and are quite satisfactory, as are also his own polariscope observations and Capt. Hills's "flash" spectrum.

The telegraphic reports state that the form of the corona was similar to that seen in the eclipses of 1886 and 1896. The east and west extensions are estimated as three radii of the Moon, and the north and south as one radius. Sir J. N. Lockyer is responsible for the statement that the longest streamer was a polar one, and had a length equal to four apparent diameters of the Moon. The brightness of the sky during the eclipse was estimated as "rather brighter than full moonlight." The following Reuter's telegram gives a graphic account of the scene and of the local feeling:—

So far as Bombay is concerned, the result of the eclipse has not quite realized general expectations. As the eclipse reached its zenith the temperature fell rapidly, and the atmosphere became perceptibly chilly. Quite an earthy smell pervaded the air. One naturally expected to see stars peep out and twinkle in semi-darkness. But the scene here was too bright for that, and rather resembled a landscape under a wintry English sun.

Crows flew from tree to tree, or circled in flights, while sparrows twittered preparatory to roosting. Kites descended and cocks crowed.

At the moment of totality the conditions were favourable at Sir Norman Lockyer's camp at Viziadrag, and the same was the case at Professor Campbell's camp at Jeur. The Sun was gradually blotted out, and a marvellous corona of pale silver-blue appeared.

The duration of totality was two minutes. Stars sprang out, and all was dead still. Native astrologers had prophesied all kinds of calamities, including a tidal wave at Bombay, and some foretold a great disaster a week hence. Religious Hindus sat down and counted their beads at the moment of contact, at the same time reciting mantras, or prayers and hymns. Here and there on the foreshore stood Parsees, Zend-Avasta in hand, and with their faces turned towards the Sun. The Brahmin priests, who are ever ready to receive alms, ceased their solicitations during the eclipse. Beggars, however, warmed nearly everywhere, and the Hindu streets were alive with the cry "Dedan sute Girhan," meaning "Give alms for the recovery of the Sun from the jaws of the dragon Ráhu."

The large gatherings which usually assemble along Back Bay on the occasion of eclipses, for the purpose of bathing in the sea, were prohibited by the Plague Committee. The few bathers to be seen tied Durab grass to their clothes, and cut some of it into pickles and preserves, to ensure that they should not be affected by the eclipse. There was general fasting, but not much alarm seemed to be left. It is the impression of some of the Hindus that when there was no Mohammedan or British Raj in India, the solar eclipses occurred once in twelve years, and that they are now more frequent on account of the increase of sins and misdeeds.

The Nizam of Haidarabad has released fifty prisoners, each of whom received present of money and clothes.

Recent Publications on Mars.

PROFESSOR SCHIAPARELLI has recently published his fifth memoir on Mars, in exactly the same form as his previous important memoirs on this planet, giving an account of his observations during the opposition of 1886*. There was only an interval of one year between the publications of his fourth and fifth memoirs,

* Osservazioni astronomiche e fisiche . . . Memoria quinta (R. Accademia dei Lincei, 1897, 50 pp. with 4 plates).

so that we may perhaps hope soon to see his more recent observations in print. We have learned a good deal about Mars since 1886, and the memoir now issued comes, therefore, rather *post festum*, especially as Mars was not particularly well situated in that year, the opposition (March 6) occurring only 26 days after the planet had passed the aphelium; but, on the other hand, the north pole was well in view, so that this much neglected region could be thoroughly examined. The Milan observations were made between January 3 and June 5, chiefly with the 8-inch refractor previously used, but after the 1st May the new 18-inch Merz refractor was also employed. As in former years, micrometric observations of the position of the polar spot were made, the excentricity of the northern spot from 104 measures being $1^{\circ}269 \pm 0^{\circ}101$ in longitude $295^{\circ}10 \pm 5^{\circ}72$, in good accordance with the result found by Dr. Lohse at Potsdam during the same opposition. The excentricity of this spot is therefore much smaller than that of the south polar spot, for which Prof. Schiaparelli in 1877 found $6^{\circ}15$. The diameter of the north spot, which on the 3rd January was 30° , dwindled down rapidly to about 8° ; but from the end of February until the observations were discontinued early in June, it is hard to say whether any further diminution took place, although the summer solstice of the northern hemisphere occurred on the 30th March. The author remarks that it is difficult to explain how this polar spot after a rapid and steady diminution is suddenly arrested in its process of dissolution, notwithstanding a constant or even increased radiation. If it is really dissolved by the heat of the Sun, some circumstances unknown to us must influence the process, for, according to terrestrial analogies, we should expect the diminution to progress with increased rapidity at and after the solstice, unless, indeed, within a certain limited area, owing to local circumstances, the snow accumulates to a much greater depth than elsewhere. Should this be the case, the position of the remnant of polar snow ought evidently to be the same from year to year, and it is therefore very important that measures of the polar spot should be made regularly during every opposition.

As usual, the greater part of the memoir is taken up by a detailed description of the surface-markings, and of the four plates appended two contain copies of drawings made at the telescope, while the two others give a fine map of the northern hemisphere and a key-map of the same. Close to the north pole an extensive dark marking, *Lacus Hyperboreus*, was found not to be usually conspicuous during the period covered by the observations; in fact this formation, at least 600 kilometres in diameter, made its appearance within two days (26–28 March) in a place where the surface had previously been bright. It does not seem likely that this can have been caused by a sudden flooding of the region owing to the melting of the polar spot, as the latter was already then much reduced in size, but it is suggested that the frozen

surface of the lake may suddenly have melted and thereby changed the colour from yellow to black. The observations do not throw any further light on the vexed question as to the nature of the "seas," but with regard to the duplication of the canals, which only took place in six cases (including some doubtful ones), Prof. Schiaparelli confirms the result first announced in his third memoir, that this mysterious phenomenon begins one or two months after the vernal equinox (12 Sept., 1885), and that it is practically over by the time of summer solstice.

A very ingenious attempt to account for the canals has lately been made by Dr. J. Joly, F.R.S., Professor of Geology in the University of Dublin, in a paper "On the Origin of the Canals of Mars" (Trans. R. Dublin Soc. vol. vi. no. 10). It is supposed, in the hypothesis put forward in this paper, that Mars at various times in very early stages of his history, when his rotation period was much shorter than at present, captured small bodies, possibly some of the minor planets, which, after circulating round him for longer or shorter periods of time, fell down on him. A small solid satellite, moving close to the surface of its primary, will give rise to certain stresses in the crust of the latter, due to gravitational attraction. The author shows that there is at any moment a circle of maximum stress in the crust, the circular base of a cone having the centre of the satellite (assumed to move slowly, relatively to the surface) at its apex, the semi-angle of the cone being 71° . It is assumed that the crust is thin and so far affected by the central lifting force as to be made unstable under horizontal compression. Thus, a satellite having a diameter double that of hobos (say 72 miles) will at a distance of 63 miles exert a stress of from 15 to 30 tons per square foot, according to what assumption we make as to the density of the body, tending to rend the crust on the surface of the planet in a circle 220 miles in diameter. The satellite must be considered as carrying the circle of stress along with it over the surface, and tangents drawn to this circle parallel to the line of motion define two lines 220 miles apart, along which the maximum stress is advancing with every return of the satellite over the same ground. Dr. Joly considers it highly probable that these repeated disturbances will lead to eruption and upheaval, in this way two parallel ridges would be produced which might be visible to us as a double "canal"; and when it is remembered that the canals are now known to pass over the dark as well as over the light parts of the surface, and that we have really no means of knowing whether they are elevations or depressions in the surface, the hypothesis seems not devoid of plausibility. It is remarkable that the presence of a satellite, moving at such a distance from the surface of Mars as to be within his atmosphere, affords an entirely different mode of explaining the formation of double canals, depending upon the atmospheric disturbance set up by the motion of the satellite and the effect of this on loose surface material. If a bullet is fired

close over a surface of loose powder it is found that the wind-track consists of parallel mounds of powder which have been blown to either side from the central line, and in many cases a central ridge is also raised to mark the passage of the bullet.

Assuming that the "canals" are elevations of the surface, Dr. Joly finds a reason for the varying conspicuousness of the lines in the natural conveyance of water by diffusion through the atmosphere, and its precipitation more abundantly as the supply of water increases with the advancing year. But he does not allude to the dependence of the phenomenon of duplication on the seasons, and this will doubtless be the most difficult point to settle, no matter what hypothesis as to the origin of the lines we may adopt. Otherwise it must be conceded that there is nothing in the new hypothesis contrary to observed facts. In the concluding portion of his paper the author shows that the observed curvature of the lines, where this is sufficiently definite to admit of investigation, is such as the composition of the motions of a uniformly rotating sphere and a point revolving uniformly round the centre of this sphere will give rise to. The great circle is, of course, not possible, as it corresponds to the particular case of a non-rotating planet; but it appeared, from an examination of Mr. Lowell's map, that the curves, if sufficiently produced, did not span 180° on the equator. This span at once determines the ratio of angular velocities of planet and satellite. The angular velocity of the satellite may be assumed invariable within the limits of distance at which it can affect the surface of the planet. Any variation in the span of the curves must therefore be due to change in the rate of rotation of Mars. It is now shown that the curves laid down on a map on Mercator's projection through the points of intersection of canals with the equator and the point of highest latitude coincide in nearly all the cases (sufficiently definite to be dealt with) with the observed curves on Lowell's map.

The hypothesis suggested by Dr. Joly is certainly an interesting one. But it is an open question whether we are justified in assuming that a number of small bodies, perhaps forming part of the host of minor planets between Mars and Jupiter, in the days when Mars was young came so near to his orbit that he was able to pick them up.

J. L. E. DREYER.

Some recent Determinations of Proper Motions.

We take advantage of the publication by Dr. Küstner, Director of the Bonn Observatory, of a small volume, 'Researches on the Proper Motions of 335 Stars,' to draw attention to the large amount of work which has recently been done in this branch of astronomy. Dr. Küstner, while Assistant at Berlin, observed in the years 1886-1891, those stars whose proper motions are given

by Argelander in vol. vii. of the Bonn Observations. He has made a systematic search in the older catalogues, and has used the material available for a thorough revision of the proper motions of those stars, applying such systematic corrections to the various catalogues as would bring them into harmony with the system of the fundamental catalogue of the *Astronomische Gesellschaft*.

The inseparable connection of proper motions with the precessional constant, and especially with the parallactic motion of the Sun and the information thus obtained as to the actual distances and movements of the stars, renders their determination the most interesting of the results to be derived from the meridian observations of stars. Now that 150 years have elapsed since Bradley's observations, and 100 since those of Piazzi, Lalande, and Groombridge, there is an extensive mine which has been and is being worked in the comparison of these with later observations.

It is hardly necessary to mention the determination by Dr. Auwers of the proper motion of Bradley's 3000 stars by comparison with the Greenwich Observations of 1861, or the important fundamental catalogues of Prof. Newcomb, containing 1100 stars with their proper motions, or of declinations of 500 stars with their proper motions by Prof. Boss. These were published between 10 and 20 years ago and are well known. More recently Dr. Auwers has published a catalogue derived from Mayer's observations, and has by comparison of Mayer's, Zach's, and Piazzi's observations with those made at Gotha in 1890 obtained the proper motions of 300 stars not observed by Bradley, and of 45 observed only in one element by Bradley. In addition a more complete discussion is given of the proper motions of about 40 more of Mayer's stars.

When the scheme for the formation of the great catalogue of the *Astronomische Gesellschaft* was first proposed, it was decided that a comparison of the observations with the earlier catalogues should be made. This has been already done extensively and carefully for several of the zones, and proper motions of many faint stars have thus been derived. The earliest catalogues on which these depend are usually Piazzi, Lalande, or Groombridge, while extensive use has been made of Bessel's and Argelander's zone observations. Generally the systematic corrections have been applied to reduce these catalogues to the *Astronomische Gesellschaft* system. The Albany Catalogue (zones $+1^{\circ}$ to $+4^{\circ}$) by Prof. Boss gives the proper motions of 500 stars with the details of their determination, including a discussion of the systematic corrections. Similarly the two Berlin Catalogues of Dr. Becker and Dr. Auwers contain the proper motions of 625 and 1300 stars respectively (zones 15° to 20° and 20° to 25° N. Decl.), with the details of the determination of such as had not previously been given. In the Cambridge (U.S.) Catalogue Prof. Rogers has given provisional proper motions of 800 stars in the zones 50° to 55° , and it is stated in the introduction to the catalogue that further

details will be given in a later volume of the 'Annals of the Harvard Observatory.' With these may be included the new Paris Catalogue, which is already published as far as 18^h, and consists of re-observations of Lalande's stars and determinations of their proper motions. Making a very rough estimate, reliable determinations have been made of the proper motion of at least 5000 stars, and there would seem to be at least 10,000 stars in the northern hemisphere with proper motion large enough to be distinctly shown by comparison of the older catalogues with the Gesellschaft and other modern catalogues. In his determination of the precession constant Prof. Newcomb points out the interesting fact that about one-third of the Bradley stars have no "motus peculiaris"; that whatever proper motion they appear to have which is not due to the accidental error of the observations is a correction to the precession and is in a great degree the parallax effect of the Sun's motion.

Three catalogues of stars with proper motions above certain limits have been published within the last few years. Dr. Stumpe gave, in *Ast. Nach.* 2999-3000, a list of 1080 stars with proper motion larger than $0''.16$, along with the authorities from which he has derived them. These were all reduced to the systems of Newcomb and Boss, and were used by Dr. Stumpe for his well-known determination of the parallax motion.

Dr. Porter has published in the Cincinnati Observations a valuable catalogue of 1340 stars whose proper motion is greater than $0''.015$ sec. δ in Right Ascension, or $0''.15$ in Declination. He has in all cases where necessary observed the stars about 1890, and appears to have referred to not less than 60 catalogues for previous observations. Full details of the determination are given as well as definitive positions of the stars for 1900.0.

M. Bossert has given in the volume of Paris Observations for 1888 a catalogue of the proper motions of 2641 stars. The limits which he adopts are $0''.010$ in Right Ascension, and $0''.10$ in Declination, deduced from observations extending over at least 50 years. This catalogue was published a few months ago.

Astronomers engaged in meridian work are doubtless familiar with these three catalogues, but it may not be out of place to draw the attention of other astronomers to them. F. W. DYSON.

The Longitude of Madras.

In the number of this magazine for September 1895 a note appeared under the same heading as above. The circumstance which called for its appearance was the fact that two officers of the Indian Survey, Capt. S. G. Burrard and Capt. Lenox Conyngham, had recently been at Greenwich, where they had been engaged in determining the arc of longitude between that place and Madras.

The note referred to gave the reasons for this determination, which may be recapitulated here. In the early days of the Madras Observatory its longitude was determined from observations of Jupiter's satellites, and by the method of Moon culminations, with results such as $5^h 21^m 6^s.0$, $14^s.0$, $9^s.4$, $9^s.0$, or $3^s.7$. The value $5^h 21^m 9^s.4$ was selected as the best of these, and was adopted in the work of the Indian Survey, where it holds place until this day. Determinations subsequent to these from Moon-culminations gave values about $5^h 20^m 55^s$ or 57^s , and the result $5^h 20^m 57^s.3$, from a discussion of these same observations, was considered as the longitude of the Madras Observatory before the era of telegraphic determinations. The telegraphic determination of the arc by the British Transit of Venus parties in 1874 is too well known to need recapitulation. The best final result appears to be $5^h 20^m 59^s.42$, although some persons who have discussed these observations make the figures smaller by almost a tenth of a second of time; but the larger value is that at present adopted in the 'Nautical Almanac.'

As above stated, the longitude now used in the maps of the Indian Survey is $5^h 21^m 9^s.4$, which is obviously in error. In 1891, when the question arose whether it would be advisable to use another value, it was considered that no value was known with sufficient certainty to justify its adoption. At the time when this discussion was in hand the authorities of the Indian Survey organized an expedition to determine the difference of longitude between some stations on the Persian Gulf and Karachi, which is a main point of the Indian Survey, and the opportunity was taken for the observers, Captains Burrard and Lenox Conyngham, to extend their operations to Teheran, and through Europe to Greenwich. The history and result of this work is now before us.

As the whole of India has been perfectly surveyed, and the difference of longitude between Madras and Karachi, a westerly station of the Survey, is well known, Karachi may be taken as the point whose longitude was to be determined. The route first suggested was Karachi—Bushire—Teheran—Odessa—Emden—Lowestoft—Greenwich, but this was finally altered to Karachi—Bushire—Teheran—Potsdam—Greenwich. The cause of this alteration in route introduces a point worth noting. Hitherto in longitude-operations it has always been considered impracticable to join up a land-line and a submarine cable, so that when there is a long link formed by a submarine cable, stations have been established on the sea-shores—either astronomical stations, so that the length of the sea-arc is determined by itself, or simply transmitting stations with intermediate clocks, by whose help the difference of the terminal clocks is determined. A third course is to connect the land-lines and the cable by relays, which is somewhat objectionable. In the case of this lately determined Madras longitude, Greenwich and Potsdam were connected by two land-lines (441 miles) and cable (280 miles), joined directly at Lowestoft and

Emden. This bold step, which proved in the result to be entirely successful, was taken partly on the advice of the Astronomer Royal, who considered it would be advisable to make Potsdam a station; but mainly owing to Mr. Preece, the Engineer in Chief of the Post Office, who not only thought the scheme practicable, but also pointed out that it would be better to make the first arc Greenwich—Potsdam instead of Greenwich—Emden, as the retardation time would be more likely to be the same in both directions, if equal lengths of land-line were joined at both ends of the cable, than if the line were non-symmetrical.

This re-arrangement of the chain made the link between Potsdam and Teheran of great length, 2626 miles of land-line with 2 of cable across the Black Sea, and this circumstance seems to have caused much trouble. The Indo-European Telegraph Company put their lines completely at the service of Capt. Burrard, and Mr. Andrews, the Managing Director of the Company, with his whole staff, helped with a will; but it was found impossible to send signals directly over the whole length of line, and a relay had to be introduced at Odessa, which was the only relay used in the work; and even with this there was much difficulty in making the clock comparisons. The telegraph arrangements between Teheran and Bushire, and also on the arc Karachi—Bushire—Jask, call for little mention, although the cordial help of the telegraph officials, without which the determination of a longitude is practically impossible, is gratefully acknowledged. Between Karachi and Jask a land-line was used, but on the other sides of the triangle, Karachi—Jask—Bushire, a cable.

As to the arrangement of observers and the consequent elimination of personal equation. In determining the three links of the circuit Karachi—Jask—Bushire, Capt. Burrard was always the easterly observer. This does not eliminate personal equation, but it is the practice of the Indian Survey to apply corrections for personality determined from observations made before and after and perhaps during the longitude, and not necessarily to eliminate. Seven differences of personal equation ($B-C$), determined between 1889 October and 1892 April, range from $0^{\circ}210$ to $0^{\circ}270$. Five determinations taken during the operations now before us range from $-0^{\circ}222$ to $-0^{\circ}318$. Another value found from an interchange of observers will be presently mentioned. On the two links which connect Bushire and Teheran, Capt. Burrard was respectively at Potsdam and Bushire, while Capt. Lenox Conyngham stood fast at Teheran. This arrangement, it will be seen, eliminates all personal equation in the sum of the two arcs, provided that the personality of either observer does not change. On the arc Greenwich—Potsdam the observers interchanged stations, Capt. Burrard being first at Greenwich and then at Potsdam, so that in this link the personal equation is again eliminated, and except for the arc Karachi to Bushire, the result of which is verified as it forms part of a circuit, the whole result is free from personality.

Little need be said of the time determinations, beyond that they were evidently made with all the skill and care that characterizes the work of the Indian Survey. The programme for a night's work on the Jask—Bushire arc, which is given as a specimen, is most comprehensive. The transit telescopes used were made by Messrs. Troughton and Simms, and were of $3\frac{1}{2}$ inches aperture and $35\frac{1}{2}$ inches focal length. The preliminary trial of the telescopes seemed to show that the springs supporting the friction-wheels, which are intended to relieve the pivots of some of the weight, exerted a lateral pressure on the axis, which vitiated the determination of level error and collimation from nadir observations. These springs were therefore discarded. Speaking of the preliminary experiments it may be mentioned that before the observations were begun the two telescopes were set up within a few feet of one another on the same meridian at Dehra Dun, and their difference of longitude determined as in actual work. A complete determination gave the result $0^{\circ}017$, the smallness of which justified Col. Gore, the Superintendent of the Survey, in giving instructions for the work to go forward.

To proceed to the results. Eleven determinations on five nights (it seems that by the method of reduction each group of clock-stars is taken as giving a value of the longitude) of the arc Greenwich—Potsdam, made between 1895 June 21 and July 1, when Capt. Burrard was at Greenwich, have a range between their extreme values of $0^{\circ}178$, with a mean value of $0^{\circ}52^m 15^s.585$. Fourteen similar determinations made on five nights between July 12 and July 22, Capt. Lenox Conyngham being at Greenwich, have a range of $0^{\circ}117$, with a mean value $0^{\circ}52^m 16^s.273$. The resulting value of difference of personal equation (B—C) is therefore $-0^{\circ}.344$, which is rather larger than the values previously determined directly, but differs only by $0^{\circ}.026$ from the value determined at Greenwich in May 1895; so that no doubt the change indicated is real. The actual value of the longitude of Potsdam east of Greenwich is the mean of the above figures, $0^{\circ}52^m 15^s.929$. There is little to be said of the arc Teheran—Potsdam, except that its length comes out as $2^h 33^m 24^s.223$, with a probable error $\pm 0^{\circ}.0080$, and that the station at Teheran was $1^{\circ}.063$ west of the station known as Stebnitzki's, which occurs in Russian geodetic publications. Bushire was found to be $0^{\circ}2^m 21^s.438$ west of Teheran, and, as has been said, the sum of this and the preceding arc give a result free from personal equation. Karachi—Bushire was measured directly $1^h 4^m 44^s.812$, and the sum of the two arcs, Karachi—Jask and Jask—Bushire, is $1^h 4^m 44^s.754$, which gives the comparatively small circuit error $0^{\circ}.058$. Taking the difference of longitude between Madras and Karachi from the results of the Indian Survey as $0^{\circ}52^m 55^s.612$, the resulting value for the longitude of Madras east of Greenwich is $5^h 20^m 59^s.113$, which shows the longitudes of the Indian Survey maps to be in error by $+2' 27''.54$.

There are now five telegraphic determinations of the difference of longitude between Greenwich and Madras, of which the resulting values are as follows, the routes and observers being briefly indicated :—

	h	m	s
A. Madras, Singapore, Vladivostock, Poulkova, Greenwich, by American and Russian officers	5	20	59 ^m 750*
B. Madras, Karachi, Ispahan, Berlin, Green- wich, by Indian and German officers ..	5	20	59 ^m 010
C. Madras, Karachi, Bushire, Potsdam, Green- wich, by Indian officers	5	20	59 ^m 113
D. Madras, Aden, Malta, Berlin, Greenwich, by Indian officers, German observers, and Dr. Gill	5	20	59 ^m 041
E. Madras, Suez, Mokattam, Greenwich, by Indian officers and English observers ..	5	20	59 ^m 416

The determination of a new value for the arc Potsdam—Greenwich is of much interest. It may be remembered that a few years ago Prof. Bakhuyzen published in the ‘Comptes Rendus de la Conférence de l’Association géodésique internationale, 1893,’ a discussion of a network of European longitude arcs; the results of this discussion were published in two columns giving the longitude of different places east of Greenwich—first on the hypothesis that the difference of longitude between Greenwich and Paris is 9^m 21^s·03, and secondly on the hypothesis that this difference is 9^m 20^s·83; Berlin is one of the places on the list, and as the arc Berlin—Potsdam has recently been determined with a result that may be relied on, we can form the following circuit errors :—

First Hypothesis. Paris—Greenwich=9^m 21^s·03.

	h	m	s
Berlin—Greenwich	0	53	34 ^s ·879
Berlin—Potsdam	0	1	18 ^s ·721
Potsdam—Greenwich	0	52	16 ^s ·158
Recent determination	0	52	15 ^s ·929
Circuit Error			0 ^s ·229

* It should be added that most of these values have been modified by subsequent discussion. Prof. Oudemans's value of A is 5^h 20^m 59^s·452. The value of B given above is Dr. Auwers's latest result. This chain originally gave 5^h 20^m 59^s·67. Dr. Auwers's reduction of D gives 5^h 20^m 59^s·233, Gen. Walker's value of E was 5^h 20^m 59^s·335, whilst the latest discussion of this series by Col. Strahan gave 5^h 20^m 59^s·422.

Second Hypothesis. Paris—Greenwich = $9^m 20^s.83$.

	h	m	s
Berlin—Greenwich	0	53	34.826
Berlin—Potsdam	0	1	18.721
Potsdam—Greenwich	0	52	16.105
Recent determination	0	52	15.929
Circuit Error			0.176

Looking at these results it may be that the new value of the arc Potsdam—Greenwich is a little small. The moral seems to be, and there is much other evidence supporting this, that two-tenths of a second of time is not too large a discrepancy to expect in longitude determinations. Capt. Burrard, with a humility which we admire, but in words with which we cannot entirely agree, remarks that, “with no limit to time and no limit to expense, with more favourable weather and *less frail* observers, the recent determination could perhaps be slightly improved upon.” It is our opinion that we have before us the result of a piece of work thoroughly well done by two capable men. H. P. H.

CORRESPONDENCE.

To the Editors of ‘The Observatory.’

Milton and the Satellites of Saturn.

GENTLEMEN,—

In one of the speeches which Milton puts into the mouth of Raphael in colloquy with Adam, he represents the angel as saying:

“_____ Other Suns, perhaps,
With their attendant Moons, thou wilt descry.”

Dr. Masson, in his ‘Notes to Paradise Lost,’ comments on this well-known passage thus:—

“A reference to Galileo’s discovery that Jupiter and Saturn have satellites.”

Dr. Orchard, in his interesting work ‘The Astronomy of Milton’s Paradise Lost,’ improves upon this by writing (p. 110):—

“Milton in these lines refers to Jupiter and Saturn, and their satellites, which had been recently discovered, those of the former by Galileo, and four of those of the latter by Cassini.”

J. D. Cassini did indeed discover four of the satellites of Saturn; but two of these, now known as Tethys and Dione, were detected

ten years after the death of Milton, and the other two, Rhea and Iapetus, subsequently to the publication of 'Paradise Lost.' I may mention that I have examined the original edition of that work, published in 1669, and the above passage is there. This was about two years before the discovery of Iapetus, and three before that of Rhea, so that the only satellite of Saturn which Milton could have heard of at the time when his great poem first appeared was that now known as Titan, which was discovered by Huygens in 1655. Dr. Masson thinks that "other Suns, perhaps, with their attendant Moons" refers to the large planets and their satellites; but I would rather agree with Sir John Herschel, who evidently thinks that the "other Suns" means the fixed stars, which it was thought likely might have systems of planets revolving round them. Otherwise it would be difficult to affix any signification to the expression, "male and female light," which probably means direct and reflected light.

Yours faithfully,

Blackheath, 1898, Jan. 5.

W. T. LYNN.

The Eye and Astronomical Observations.

GENTLEMEN,—

Last week we had an interesting guest here: an oculist from the Vienna Hospital who is an amateur astronomer. He told me that he thought it a pity that very few observing astronomers have their eyes examined by an experienced oculist, as he thought that many of the discordances one finds in measures of double stars and in interpretation of planetary detail, as well as personal equation, might have their origin in the particular constitution of the eyes. He examined my eyes and found that I did well in observing exclusively with my right eye, which is, although exceedingly short-sighted, quite normal in all other respects, while my left eye, although less short-sighted, is weak in sight and astigmatic, so that measures made with the left eye would give erroneous results. The oculist asserted also that it is an error to believe that one can correct measures made by an abnormal eye by turning the head, as many observers do, believing that they thus compensate their defects when they observe first with the eyes *parallel* to the thread and then *perpendicular* to it, for *the eye does not turn with the head!* He said, too, that many of the strange results of certain astronomers (canals on Venus and Mercury, shadows on the Saturnian ring A, peculiar gulfs and half-moons on the crape-ring, irregular terminator of Venus, &c.) may be the natural effect of the imperfection of the eyes. The circumstance that several observers believed the "garnet spots," and even the principal belts, of Jupiter to be *black* is a *certain* sign of Daltonism, which is more common among astronomers than is commonly thought. The oculist also believed that these peculiarities of the eyes affected the measures of double stars: some persons are inclined to get *greater* values, others to get *less*. It is a fact that

Schiaparelli's measures give almost invariably *less* values than others.

This was interesting to me on account of the fact that my measures of the Jovian satellites had given a great polar flattening. I begged the oculist to examine my eye with particular care in this respect. He did so, and declared that there is *not the slightest disposition* of my eye which would make him suppose that my eye is inclined to measure a polar diameter *less* than an equatorial one. He found also that my eye is very sensible to faint nuances of colours, and is not in the slightest degree affected with Daltonism. He ended his examination with the remark that many astronomers would be distressed to hear the results of a very careful examination of their eyes!

Hoping that these hints may induce all observing astronomers to let their eyes be *carefully* examined by a *clever* oculist (in their own interest and to the profit of observational astronomy), I have the honour to be,

Faithfully yours,

LEO BRENNER.

Manora-Sternwarte,
Lussinpiccolo (Istrien), 1898, Jan. 8.

OBSERVATORIES.

HARVARD.—The fifty-second Annual Report of the Director of the Harvard College Observatory contains the record of work for the twelve months ending 1897 Sept. 30. It is convenient to follow the arrangement of the Report and mention in turn the work done in each branch.

East Equatorial.—This instrument is provided with a polarizing photometer, and is used for determination of light variation of variable stars and of the satellites of Saturn (Iapetus was measured on 24 nights, Titan on 3), and also to make photometric measurements of Jupiter's satellites while undergoing eclipse. The number of such eclipses observed was 28, which brings the total number of this series to 627. With this instrument observations of S Cephei were also made to determine the effect of colour on measures made by different observers and by different measures.

West Equatorial.—This instrument has also been used for observation of variable stars. A long series of observations of the variation of β Lyræ has been made with this instrument.

Meridian Circle.—Prof. W. A. Rogers, who has charge of the work of this instrument, is still continuing the reduction and publication of the zone observations made for the great catalogue of the *Astronomische Gesellschaft*. The last volume of observations of the northern of the zones allotted to Harvard has been published. The observations of the southern zone, $-9^{\circ} 50'$ to $-14^{\circ} 10'$, are being revised: that is, those stars are being re-observed the previous observations of which were insufficient in number or

were discordant. Very little remains to be done in the work of revision.

Meridian Photometer.—Prof. E. C. Pickering has again made an immense number of observations with this instrument. The record of the total number of settings was 100,052, which surpasses that of any previous year. The work to which this instrument has been especially devoted for many years past is the photometric measurement of the brightness of all stars in the sky north of declination -40° , of magnitude 7.5 and brighter. This work is now nearly completed. When it is quite done the instrument will be sent to Arequipa, where similar observations will be made of the stars between -40° and the south pole, thus completing the survey for the whole of the celestial sphere. The meridian photometer has also been used during the year to make observations of stars of the Algol type and of some of the planets.

The Draper Memorial Telescopes.—The series of photographs of spectra of stars has been continued with the 8-inch Draper telescope and in Peru with the 8-inch Bache telescope. The number of photographs taken with each is respectively 3032 and 3022. The ladies who are entrusted with the examination of these plates have been able to announce many interesting discoveries during the year. The 11-inch telescope continues to be used for photographing the varying light of stars and of Jupiter's satellites during eclipse. The Assistant in charge of this instrument has been making an investigation on the effects of differential refraction and flexure on the form of photographic images. He states that by giving a suitable rate to the driving-clock circular images may be obtained without guiding even when the exposure is as long as an hour, and he hopes to perfect an apparatus which will introduce a flexure to correct automatically for refraction. Judging from a remark made on this subject, we think that a recent paper in the 'Monthly Notices' will be of service to him.

The work at the Arequipa Station, which is still under the direction of Prof. Bailey, continues to be vigorously continued. With the 13-inch Boyden telescope 845 photographs have been taken, mainly charts of clusters, charts for detection of parallax, and spectra of the brighter stars. The photographic telescope, presented by the generous Miss Bruce, the erection of which at Arequipa was announced last year, has been largely used, but the plan of work originally laid down for this instrument has been abandoned. It had been proposed to make a complete photographic chart of the whole sky, and possibly, with this instrument, which has as objective a doublet lens of 24 inches aperture, and so covers a large field and necessitates only short exposures, it would have been possible to photograph either hemisphere in a year; but it is now thought that more valuable work could be done by taking pictures of particular portions of the sky, the Magellanic clouds, star-clusters, or large nebulae. Already 662 photographs have

been taken with this instrument, some of which are spectrograms taken with a prism.

We have left Prof. Pickering's introductory paragraph until the last. He begins his report by stating the principal needs of the Harvard Observatory. The institution is not in any want of income, for the Director feels that, as compared with other observatories, his annual resources are large. He points out that he is able to employ 40 assistants, 21 men and 19 women, and to carry out to completion many investigations. He does not wish any increase in this direction, nor does he wish any larger instrument for Harvard proper. A larger telescope might be of advantage at Arequipa, but the chief instrumental requirement at the parent observatory is a new mounting for the 15-inch equatorial. Beyond this the desideratum at Harvard is new buildings. Prof. Pickering states the need for a new library building, new computing-rooms, machine-shop, and store-rooms for manuscripts and photographic plates, and gently suggests that some wealthy patron of astronomy might immortalize himself by paying for such buildings, which could be called after his name.

WASHINGTON. U.S. NAVAL.—It is a long time since we had occasion to mention a Report from the Director of this Observatory, and now we have before us two, recently received, from which to make abstracts. The first of these, signed by Captain McNair, of the U.S. Navy, is for the year ending 1894 June 30, the second, for the same date in 1897, is signed finally by Commodore Pythian, but Prof. Wm. Harkness, as Astronomical Director, is responsible for the purely astronomical part of the report. With these we have received a note saying that the reports for the intermediate years were published in the Reports of the Secretary of the Navy, and will probably not be issued separately.

The last Report mentioned in these pages was for 1893, and gave some account of the new Naval Observatory, and the improvements and repairs which had been or were being made to the instruments before removing them to their new home. The Report for 1894 continues to give similar details. At that date the 26-inch equatorial was almost ready for use, the objective of the 12-inch equatorial was not then made, but a 9.6-inch object-glass had been fitted, and was used for minor miscellaneous purposes, such as the entertainment of visitors. The making of the large transit-circle, with objective of 9 inches diameter, which it was proposed to have for the Observatory, was not yet begun, but the observation of the stars for the zone -14° to -18° of the *Astronomische Gesellschaft* Catalogue were being made with a smaller instrument. The prime vertical instrument had been used for a determination of the constant of aberration.

The more recent Report relates that these instruments are all

in good order and have been used with considerable vigour. The 26-inch equatorial, which is under the charge of Prof. S. J. Brown, has been used for the observation of positions of faint comets, for the observation of the Satellites of Mars, for measuring the diameters of Mercury and Venus by means of a filar micrometer, and also for observations of double stars. It is proposed to make a general revision of the more important double stars, such as well-known binaries, suspected binaries, and new and difficult doubles. Owing to bad weather only 98 observations have as yet been secured on 39 nights. Of these nights of work 15 proved fairly good, but on only three of them could a power so high as 888 be used.

The 12-inch equatorial is in the charge of Prof. Edgar Frisby. This seems to be used chiefly for showing celestial objects to the public. Tuesday and Thursday evenings in each week are set apart for the reception of visitors, and during the year 3260 permits of admission were granted by the Observatory, besides others issued by the Bureau of Equipment. In addition to this, this equatorial is used for observations of occultations, Jupiter's Satellites, and comets which are within its range.

Mr. A. N. Skinner is in charge of the 9.14-inch transit-circle. With this instrument 4404 observations were made during the year, which include observations of the Sun, Moon, and planets, clock and adjustment stars, and stars for the Zone Catalogue. The observations for this zone are practically completed, but the reduction is much in arrear, as are, indeed, the reductions of all the observations made with this instrument, owing to the fact that there have been various changes on the staff, which naturally causes delay. A star-catalogue from transit-circle observations is being prepared by Prof. Eastman.

With the prime vertical transit-instrument, which is in charge of Mr. G. A. Hill, observations were made for the determination of variation of latitude, of the constants of aberration and nutation. The result of this research, so far as relates to the determination of latitude, was published in No. 404 of the 'Astronomical Journal.'

The above are the main facts of Prof. Harkness's Report as Astronomical Director of the Observatory, but the pamphlet also contains a section on the work of the Nautical Almanac Office, which is also a Naval Department, and from this we learn for the first time that Prof. Hendrickson, who, as we mentioned last June, was put in charge *vice* Prof. Newcomb on 1897 March 12, was detached on June 30, and Prof. William Harkness was directed to assume the duties of Director of the Nautical Almanac in addition to his duties as Astronomical Director of the Observatory. In this section it is stated that the publication of the ephemeris for 1900 was delayed owing to the introduction of new tables, constants, and other data. The constants here referred to are not, we believe, those adopted in accordance with the resolutions of the Conference held at Paris last year. We are glad to hear of

this Observatory being again in full work, and to find the American Ephemeris under the direction of such a capable man as Prof. Harkness.

PUBLICATIONS.

THE 'BULLETIN DE L'ACADÉMIE IMPÉRIALE DES SCIENCES DE ST. PÉTERSBOURG' for Jan. 1897 contains a report of the Russian observations of the total solar eclipse of 1896 Aug. 9, made at Novaya Zemlya by MM. Kostinsky and Hansky, accompanied by reproductions of the photographs and a composite drawing. This is followed in the March number of the 'Bulletin' by M. Hansky's complete and detailed discussion of the corona, showing the connection between its forms with other manifestations of solar energy.

Without a detailed drawing it is not easy to follow his general description of the corona, but many of his conclusions are of great interest and suggestiveness.

He points out that in general all "closed" rays have a somewhat darker centre, from which we may conclude that they are hollow, and he especially notices the dark spaces round the prominences, above which the coronal rays frequently bend inwards so as to form a kind of arch over the prominence. This is in exact accordance with fact, as shown by the photographs, and the arrangement of the coronal rays round the brighter prominences furnishes a strong argument for the connection between corona and prominences—a connection which M. Hansky strongly insists upon. It is not, however, easy to see how the assumption of hollow coronal rays can be reconciled with his further contention that the central portion of the ray is that in which the velocity of its particles is at a maximum.

The author thinks that nearly every coronal ray has a prominence corresponding to it, though of course the prominence may not be always visible upon the eclipse photograph, owing to its not being sufficiently near the limb. He has, therefore, further examined the prominences observed a few days before and after the eclipse, and finds confirmation of his view, which, indeed, has much probability.

M. Hansky draws special attention to the dark veins shown in the corona in the lower part of the equatorial region, which are certainly some of the most remarkable features of the corona of 1896. It may be mentioned that these are well shown on the plates taken by Sir G. Baden-Powell's expedition. One dark vein distinctly outlines a bright prominence, and above the same prominence is shown on the English photographs an extremely remarkable dark ring of a somewhat elliptical form. M. Hansky considers that these veins are probably caused by rapidly-flowing streams of hydrogen, cooled by expansion, and he suggests that

the dark spaces round the prominences are also due to great quantities of cold light-absorbing gas.

As the author truly says, the study of the form of the corona is rendered extremely difficult by the fact that it consists of rays proceeding from the Sun at every possible angle with the line of sight, but projected upon one plane, which thus presents a confused mass of overlapping rays. This, of course, is increased in the case in the portions of the corona nearest the limb.

From a consideration of the prominences it is shown that over the whole the most considerable coronal streamers are in regions of greatest solar activity, as shown by prominences. Tables of prominences for a series of years show general agreement of the curves of prominence frequency and distribution with the corresponding curves of sun-spots. The memoir concludes with a summary of observations of the form of the corona from 1860-1896, showing the decided evidence of coronal periodicity, but the author considers that the observations are as yet not sufficiently numerous to be consistent to *certainly* prove the connection between this period and that of sun-spots or other manifestations of solar energy.

We have only been able to briefly touch on the principal point in a paper of great interest and suggestiveness. By the kind permission of the author we are enabled to give a reproduction of his series of views of the coronas of 1860-1896, with a sketch of the corona of 1900, which M. Hansky ventures to predict.

W. H. W.

THE DISINTEGRATION OF COMETS*.—In this memoir, which originally appeared in the 'Bulletin Astronomique' and has now been republished, the writer points out that many phenomena of periodic comets observed in recent years suggest the conclusion that they are undergoing a gradual disintegration. He shows that we can account for this by the different gravitational action of the Sun and Jupiter on different parts of the comet, without having recourse to non-gravitational forces (repulsive force, electrical and thermal actions), which, nevertheless, probably assist in the process.

He treats comets as spherical aggregations of particles, the density being simply a function of the distance from the centre, and shows that the condition of stability of a particle within the comet is that

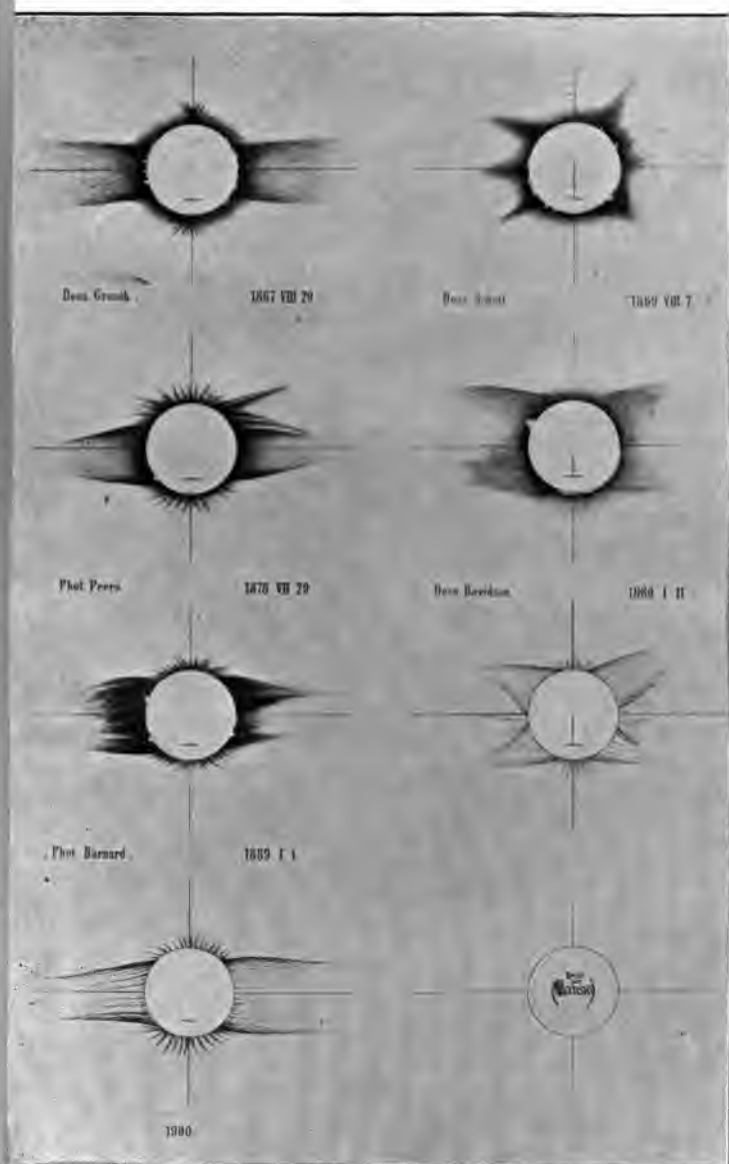
$$\frac{\mu}{M} \left(\frac{a'}{\rho_0} \right)^3 > 3 + 5e'^2.$$

Where a' , e' are semiaxis major and eccentricity of comet's orbit, M , μ masses of Sun and comet in gravitational units, ρ_0 the radius of the comet.

From this it results that the more elliptical the orbit the greater is the chance of disintegration.

* Étude sur la Théorie des Comètes Périodiques.—O. Callandreau.

[To face p. 102.



CORONA.

The radius of the sphere of stability increases with the speed of the nucleus.

The ratio of the radii of the spheres of stability at aphelion and perihelion is $\left(\frac{1-e'}{1+e'}\right)^{\frac{2}{3}}$.

Introducing Jupiter's action as well as the Sun's, this ratio must be multiplied by $\left(1 + \frac{m'' r'}{M \Delta}\right)^{\frac{2}{3}}$.

Where m'' is Jupiter's mass, $\frac{r'}{\Delta}$ the ratio of the distances of the comet from the Sun and Jupiter.

For most periodic comets of the Jovian system the disintegrating forces at aphelion are shown to be considerably greater than at perihelion.

The several portions into which the great comet of 1882 divided after perihelion are considered as an example of disintegration under solar action alone.

Biela's comet, the comet 1889 V., Wolf's Comet, and the comet 1892 V. (Barnard) are considered as examples of disintegration brought about by Jupiter's action when the comets were near aphelion.

He points out in conclusion that the hypothesis of disintegration removes the difficulty felt by many astronomers, viz. the immense interval of time and the immense number of comets that would be required if all the comets of short period had previously been moving in parabolas, and had been brought into their present orbits by the action of Jupiter; for a comparatively small number of captured comets, by repeated subdivisions, might produce the existing family.

A. C. D. C.

NOTES.

COMET NOTES.—Winnecke's Periodic Comet was picked up on Jan. 1 by Mr. Perrine at the Lick Observatory.

Mr. Hillebrand has pointed out (Ast. Nach. 3471) that his search ephemeris in Ast. Nach. 3447, of which we gave a portion last month, was really computed for Berlin noon, though stated to be for Berlin midnight. Making allowance for this alteration, the observed R.A. of the comet was 14 seconds greater than the predicted R.A., and the observed declination 1'6 south of that predicted. These corrections have been applied in the following ephemeris, which is for Berlin midnight:—

	R.A.			S. Dec.	R.A.			S. Dec.
	h	m	s		h	m	s	
Feb. 4....	17	39	8	11 28	Feb. 20....	19	0 10	13 50
8....	17	58	44	12 11	24....	19	21 12	14 10
12....	18	18	49	12 49	28....	19	42 19	14 23
16....	18	39	20	13 23				

The comet passes perihelion about March 20, is nearest to the Earth (125 millions of miles) about Feb. 27, and is brightest about March 13. It was very faint when first seen, but will probably be within reach of moderate instruments at the end of February. It rises some $3\frac{1}{2}$ hours before the Sun in the middle of the month.

Perrine's Comet (*b* 1897) was observed at Mount Hamilton till Nov. 16, at which time it was very difficult to observe, presenting no well-defined point for measurement; a region at some distance from the head might readily have been mistaken for the latter. The comet was photographed on Oct. 17, the length of the tail on the plate being 10'.

Ast. Journ. 422 contains elements of the comet computed by R. T. Crawford from Mount Hamilton observations of Oct. 16, 31, Nov. 15. These are probably the most accurate elements yet published:—

$$\begin{array}{rcl} T = 1897 \text{ Dec. } 8.55003 \text{ G.M.T.} \\ \omega \dots\dots\dots 65^{\circ} 48' 38'' \\ \delta \delta \dots\dots\dots 32 \quad 2 \quad 57 \\ i \dots\dots\dots 69 \quad 35 \quad 52 \\ \log q \dots\dots\dots 0.13269 \end{array} \left. \vphantom{\begin{array}{l} \omega \\ \delta \delta \\ i \\ \log q \end{array}} \right\} 1897.0.$$

Ast. Journ. 421 contains a series of observations of d'Arrest's Periodic Comet (*a* 1897) made at Mount Hamilton by Mr. Perrine. They extend from Aug. 8 to Oct. 3, 1897. The comet was at first easy to measure, with a well-marked condensation 10" in diameter; this, however, had almost disappeared by the end of August, and the comet grew steadily fainter. It was looked for in vain on Oct. 4 and 24.

A. C. D. C.

MINOR PLANET NOTES.—The planet DG, discovered by M. Charlois on Aug. 25 last, has been shown by M. Coniel not to be new, but to be identical with (188) Menippe, discovered in 1878, which has been missing since that year ('Bulletin Astronomique,' Jan.). Thus only seven new planets were discovered in 1897.

The following planets have received permanent numbers:—

DH (Charlois, Aug. 25) .. 426 | DK (Villiger, Nov. 18).... 428
DJ (Charlois, Aug. 27).... 427 |

A. C. D. C.

OBITUARY.—DR. OSCAR STUMPE. Our readers will learn with regret that on the last day of 1897 death claimed an earnest astronomical worker in the person of Dr. Oscar Stumpe at the age of 36. In 1883 he was studying mathematics and astronomy at the Berlin University, filling up his spare time in reporting the

meetings of the Reichstag and Landtag. He then went to Bonn, where in 1890 he obtained his degree of Doctor by a masterly dissertation on the Motion of the Solar System in Space, a subject which continued to occupy his mind until his untimely death. We have from time to time given outlines in these pages of his work. Dr. Stumpe assisted Dr. Deichmüller in the computation involved in the Bonn Zone Catalogues, and in the spring of 1891 returned to Berlin, where he helped in the work on the zone $+15^{\circ}$ to $+20^{\circ}$ of the Ast. Gesell. Catalogue. Since that time he has been with Dr. Auwers, who cannot speak too highly of his work in comparing the Zone catalogues, or of the abundant help which he gave in the construction of the fundamental catalogue.

A. KAMMERMAN. The obituary list for the past month also includes the name of this gentleman, who was an Assistant at the Geneva Observatory. He has had charge of the Plantamour equatorial of this Observatory for the past 14 years, and has done much useful work relating to chronometers. Mr. Kammerman was only 36 years old at the time of his death, which happened comparatively suddenly.

E. LINDEMANN. Announcement is also made of the death of M. Edward Lindemann, scientific Secretary at the Observatory of Poulkova. Besides his duties as secretary and librarian, M. Lindemann occupied himself in the study of stellar photometry and of variable stars. He died on 1897 Dec. 22, in the 56th year of his age.

THE WEATHER OF 1897.—The following remarks on the weather of the year 1897 are derived, by the kind permission of the Astronomer Royal, from the Greenwich records. The highest temperature in the year was $90^{\circ}2$ on June 24th, and the lowest $23^{\circ}3$ on December 24th. With the exception of a few cold days at the beginning of the month of December and again near Christmas Day, the winter has been exceptionally mild. In the whole year there have been only 32 frosty days, the smallest number since 1884, when there were 26 such days. The mean annual temperature was $50^{\circ}3$, which is $0^{\circ}9$ in excess of the average. Last year (1896) the mean was $50^{\circ}2$; in 1893 it was $51^{\circ}0$, and in 1884 $50^{\circ}7$. The sunniest month was July, with a total amount of bright sunshine of 253 hours, or 51 per cent of the possible amount, followed by May with 252 hours, which is equivalent to 52 per cent. of the possible duration. There were a larger number of sunny days also in December than had ever before been experienced in that usually gloomy month, the sunless days in the month only amounting to 11. The rainfall for the year was 22.13 inches, which is 2.22 inches below the average for the preceding 56 years. In July the rainfall was only 0.73 inch, being smaller than any July rainfall since 1885, when it amounted to 0.50 inch, whilst in October (usually the wettest month in the

year) the rainfall was only 0·48 inch, being the smallest October rainfall on record. The deficiency of rainfall in October, as compared with the average, was no less than 2·42 inches. W. C. N.

A VERY LARGE PROPER MOTION.—It seems that Groombridge 1830 is to lose its pride of place as the fastest traveller of the so-called fixed stars. In *Ast. Nach.* No. 3466, Dr. Kapteyn publishes a note stating that in examining a plate of the Cape Photographic Durchmusterung he discovered a star which apparently had a large proper motion. The star is contained in the Cordoba zone catalogue, where its place, depending on two observations made at the mean epoch 1873·04, is given as R.A. $5^h 6^m 40^s\cdot61$, Dec.— $44^\circ 58' 17\cdot6$. From comparison with the places found from reduction of a Cape photographic plate, and with equatoreal and meridian observations of the star made last year, Dr. Kapteyn deduces a proper motion of $+0\cdot621$ in R.A., and $-5''\cdot70$ in declination. The corresponding quantities for Groombridge 1830 given in the Greenwich 1880 catalogue are $+0\cdot3461$ and $+5''\cdot776$. The declination of Groombridge 1830 is about $+48^\circ 30'$, so that the movements on a great circle are respectively $8''\cdot707$ and $6''\cdot723$.

DIMENSIONS OF THE SATURNIAN SYSTEM.—Herr Leo Brenner has been kind enough to send us the final result of his measures of Saturn and his rings. The actual measures were originally published in *Ast. Nach.* No. 3461, but he has modified these by rejecting the measures of August 28, which he considered affected with some error, and now gives as final:—

Ring A.	Outer edge	$40\cdot64$
"	Inner edge	$35\cdot37$
Ring B.	Outer edge	$34\cdot13$
"	Inner edge	$26\cdot24$
Ring C.	Outer edge	$25\cdot16$
"	Inner edge	$20\cdot71$
Equatorial diameter of the Ball		$17\cdot97$

It appears from his letter that the outer edge of Ring C, which he has measured, corresponds with the marking which Herr Brenner previously reported as having been discovered by Mrs. Manora.

THE NEBULA OF ORION.—A question was asked at a recent meeting of the Royal Astronomical Society (see No. 262, p. 39) as to whether any change had ever been noticed in the Nebula of Orion. An answer to this is perhaps furnished by Mr. Leavenworth, who,

in No. 414 of the 'Astronomical Journal,' states that a star not shown in previous pictures appeared on photographs taken at the Observatory of Minnesota on February 24 and in September 1897. It is of about magnitude 13, and was not shown on a plate taken 1897 January 25.

DIRECTORSHIP OF THE VATICAN OBSERVATORY.—Prof. G. M. Searle, Professor of Astronomy in the Catholic University of America, has been appointed by the Pope to the directorship of the Vatican Observatory, in succession to Father Denza, who died in December 1894.

MR. R. T. A. INNES, writing from the Cape, says:—"On 26th Dec. last I swept on β Toucani, a 27" double, known and unchanged since the days of Lacaille. According to the Harvard Southern Photometry the magnitudes are $\beta_2=4.33$ and $\beta_1=4.50$, and in the Harvard Circular, No. 18, the latter star is noted as triple (or multiple) within 30". I saw none of these companions, which are evidently beyond the 7-inch. (At Arequipa a 13-inch refractor was used.) β_2 is, however, a fine double, a rough estimate giving mags. 4.7 and 5.7, $300^\circ \pm$, $0''.7 \pm$, both yellow. β_1 is a white star. The wide pair has a common proper motion of about $0''.10$ per annum."

At one of the conferences which took place in connection with the opening of the Yerkes Observatory, two small but not unimportant points in the practice of spectroscopy were discussed. It was resolved by the Editorial Board of the 'Astrophysical Journal' that in the printing of tables of wave-length, the *short* lengths should be at the top of the column, and that in printing maps of spectra the red end should be on the right, except in cases where a wish to the contrary is expressed by the author of the paper.

OWING to pressure on our space, we are compelled to hold over the second instalment of Mr. Dunkin's article on the 'Nautical Almanac' until next month. We have also in hand, among other matter, a letter by Dr. Johnstone Stoney relating to his work on the Atmospheres of Planets and Satellites, which was mentioned last month in this magazine.

THE Gold Medal of the Royal Astronomical Society has been awarded this year to Mr. W. F. Denning, "for his meteoric observations, his cometary discoveries, and other astronomical work." We need scarcely say how glad we are to be able to make this announcement, and heartily congratulate our esteemed contributor on this official recognition of his valuable work.

WE have hanging by our writing-table a copy of Mr. Mee's "Amateur Observer's Card Almanac," which we find of service. It shows at a glance the astronomical and meteoric phenomena which will happen on every day of the year.

WE hear that M. Hansky, whose excellent memoir on the solar corona is mentioned on page 101 of this number, is now attached to the staff of the Meudon Observatory as solar physical observer.

FROM AN OXFORD NOTE-BOOK.

IT was intimated in the last number that the Note-Book had started on an expedition to observe the Total Solar Eclipse of Jan. 22 in India, and the last notes were posted at Marseilles. The present batch is sent from Bombay soon after arrival. We are about to start for the eclipse station in Central India, but as yet our doings have not been concerned with eclipse work at all. An apology is thus needed for the irrelevance of the following paragraphs; but I don't like to think of my little corner in the Magazine being empty, and I have nothing else to fill it with. By next month I may be able to say something of preparations for an eclipse in the jungle, where "the evening's amusement consists in listening to the tigers sharpening their claws on the tent-pegs." [I am sorry to say this may be the only statement of Col. Rivers that I shall be able to quote, as he is not with us this time.]

AT Marseilles we found the good steamer 'Ballaarat,' which had had a pretty lively time of it in the Bay, as her funnels showed. Those who had come in her gave a graphic description of this period, and we felt quite glad to have escaped it. From Gibraltar, however, the weather had been beautiful, and so it continued to Brindisi (and, indeed, up to the present moment). We found plenty of lively people on board, and "mixed double tournaments" at "bull" and "shovel-board" were soon started. (It is with considerable pride that I record here the winning of these tournaments by the Members of this Expedition, with the assistance of their partners.) Between the games we looked at Corsica and Sardinia, or at Scylla and Charybdis, or other points of interest, as they were pointed out to us by the Chief Guide. I may only darkly hint at the identity of the Chief Guide by saying that he was seeking distraction from the cares of the Post Office by a voyage in these seas, and that he knows all about telegraphy, especially without wires; but he made a splendid Chief Guide,

never volunteering information, but promptly furnishing it on request, no matter how often the request was repeated. I heard him myself answer the question "Which is Scylla and which is Charybdis?" five times in seven minutes, and then I went away to avoid the crowd. It is worthy of remark that no one seemed to know Mark Twain's story of the enthusiastic pilgrim who appeared on deck at an uncomfortable hour to see Scylla and Charybdis, because they were mentioned in the Bible, and who was found to have confused them with Sodom and Gomorrah. Have we given up reading Mark Twain now as well as Dickens?

BRINDISI on Sunday morning, Dec. 19, and the overland mail not being due till the evening, we spent the day more or less on shore. The Chief Guide showed us the objects of interest, but these were few. The glories of Brundisium are indeed departed! What would some of the old nobles think of our modern civilization if they could see the present condition of their old home? The contrast between the past and the present would be so much in favour of the former that cases of simple stagnation, where things had not improved, but still had not gone backwards, would stand out in relief. One such we noted in the shape of a potter making his clay jars on a wheel which he kicked round with one foot, and drying them in the Sun, just as potters did thousands of years ago. [N.B.—These observations and reflections are mostly those of the Chief Guide, appropriated without his permission.]

THE main industry of Brindisi at present seems to be the sale of matches. Not even in the Strand is one oftener invited to buy matches. A reason may be found in the stringent regulations against the carrying of matches on board the P. & O. steamers. In the Handbook we are told that a person who sent for shipment a package of wearing apparel, containing two boxes of lucifer matches without declaring the same, was fined £50 and costs; and if the inhabitants of Brindisi have been studying this handbook, they have no doubt painted a fancy picture of passengers craving for the forbidden fruit (rightly associated with Lucifer), and disembarking with the sole object of acquiring it. They also sell oranges, offering them at fourpence each, and eagerly accepting a halfpenny for three if they get the chance: and there are cameos and nice things in tortoise-shell and mother-of-pearl; but you cause grief if you do not buy matches.

IN the evening we were attracted by the sound of a barrel-

organ to an open square where a showman was inviting an apathetic crowd to enter a brilliantly-lit building, which turned out to be a waxwork exhibition. There was Cupid solemnly stabbing with his dart the bosom of a sleeping damsel; a mother imploring a fierce lion not to eat her babe-in-arms; shipwrecked mariners on a raft; and other exciting representations. The bosom of the damsel heaved, the lion wagged his head, and the raft pitched and tossed, all in a most natural way; but my attention was rivetted on the central group, where an astronomer was looking through a telescope at the Moon. The Moon was a man's profile in crescent form, stuck on a pillar for some reason, and periodically there appeared from behind the face a hand of which the thumb sought the nose of the Moon in a manner which need not be further described, whereat the astronomer turned to the audience and expressed emotion by gesture. I had no idea of finding Astronomy encouraged in this way when I entered the building. There was a lady demonstrator to explain the exhibits, and she was making a long speech about the lion and the baby. I waited to hear what she would say about Astronomy, but her lecture was disappointingly brief, and the audience moved on rather quickly to the shipwreck. One must be content to allow scientific education to proceed slowly.

FROM Brindisi to Port Said; weather fine and mild, but not warm; more games and more scenery (but, alas! no Chief Guide to explain it—he left us at Brindisi); and we make acquaintance with the new arrivals and settle down for the main part of the voyage. Seven or eight whist-players ("of sorts") on board, so there is no difficulty in keeping a rubber going most of the day. The whist-players are blamed as unsociable or envied as having an occupation according to the mood of the critic; but they are probably the happiest people on board, not even excepting the three boys. At any rate, the boys sometimes find themselves without occupation, which does not happen to the whist-players, unless the boys start a boxing-match or a shouting-tournament in the smoke-room, when the whist has to be interrupted to turn them out.

THREE times "tied up" in the Suez Canal. When two boats meet, one of them has to be tied up while the other passes. We meet four boats and are tied up three times, owing, as one of the officers sarcastically remarks, to our having the mails on board. But at last we are fairly in the Red Sea, and the punkahs are started. It is cool for the Red Sea, only about 85° or so; but still we are glad of the punkahs at meal-times. This morning, at breakfast, a passenger, "who likes to know," told us how they

were worked. "You would scarcely believe," he said, "what a strong pull it takes to move these punkahs. When I went on deck last night, after dinner, and saw the two boys pulling their cords in that easy way, I thought I should like to know how much work they were doing. So I asked one of them to let me take his cord for a time, and I was quite astonished at the force required. The boys must be very strong." "Yes!" said the officer across the table, "we heard you asking, and so did the chief steward, and you may like to know that when the cord was handed to you it had at the other end not only a punkah, but about 16 stone of chief steward."

APPROACHING Aden we asked whether there was anything to see ashore. The first officer said he once went ashore there, and he mentioned a sum (I forget the exact value) which might induce him to repeat the experiment. This was discouraging, but not so disappointing as it might have been. We had already touched at so many places that we were almost sated with this form of sensation; and as Aden was ultimately reached about 2 A.M. no one seemed anxious to go ashore. There were some enquiries from ladies whether any merchants were coming on board, and one gentleman gallantly offered to go and see; but his wife soon wrecked that little scheme, though she had to give up asking for merchants. Presently a passenger came on board. We congratulated him upon his rescue, and asked how long he had been castaway; but he shamelessly declared that he had gone to Aden of his own accord and stayed there ten days, and it was quite a pleasant place. We found afterwards that he had a phonograph with him; and doubtless the echoes of civilization which he was thus enabled to listen to had sustained him during the dreary time of exile.

SOME Indian newspapers were put on board at Aden. The following paragraph in one of them attracted attention. It has the look of a conundrum, and indeed makes a very fair puzzle, on which several people tried their skill before the correct solution was found:—

The Dowager Maharanee of Vizianagram has decided to adopt the present minor as the son of her late husband. The old Maharajah, father of the late Maharajah minor, will therefore become the brother of the latter and succeed in the family title.

THOSE who travel learn among other things how badly telegraph messages may be sent. At Brindisi we had heard of the tragic end of Mr. William Terriss, and of the nearly simultaneous death

of M. Alphonse Daudet. I hope it will not seem to be making light of serious matters if I reproduce here the words of a telegram posted by a well-known Agency at Port Said. We found this telegram on our arrival, several days after these sad events, so that the hopeless muddle cannot be excused on the ground of haste. Such instances are by no means uncommon. It is hard to understand why those who live abroad should have their news mutilated in this abominable way. This is the telegram :—

Alphonse Daudet actor of William Terriss's Theatre stabbed at stage door by a man said to be a late superintendent named Arndt.

It should have been mentioned that we spent Christmas Day very happily in the Red Sea. We had a cricket match in the afternoon between the 1st and 2nd saloons, and all joined in a general festive evening. Cricket became a daily occurrence from this time till we reached Bombay. We had no hot weather, and only one day of anything to be called movement : altogether a most delightful voyage. If it was a day or two longer than we expected (we arrived in Bombay on Monday morning), the day or two were pleasantly spent ; and there was no bitterness in our laughter when we came in sight of the lights of Bombay and then turned tail and spent the rest of the night cruising up and down, to avoid going into harbour before dawn. We thoroughly enjoyed the joke, as a fitting close to a voyage in which the boat had been slowed down to 7 or 8 knots for the last day or two. The fact is, it became clear about Friday that we could not reach Bombay much before sunset on Sunday ; and it was thus determined to be content with Monday sunrise. The Captain had to stand some chaff, of course. Anxious enquiries were made of him how soon they would send to look for us, or whether there was any chance that India had been submerged. One passenger threatened to write a book called 'Loafing in the Indian Ocean.' But he was equal to them all. He said his ship had got tired of carrying passengers, and he could not blame her ; or he referred to a telegram received at Aden from Bombay, begging him to keep his present contingent at sea as long as he could. However, here we all are at last in Bombay, and a beautiful place it is ; and that clever P. & O. Company has lost one of my trunks, so that I have no clean shirts. Fortunately the instruments seem to be all right. We are to start in a day or two for Sahdol, in Central India, for the Eclipse Camp, which Capt. Burrard is preparing. He writes us that it is in dense jungle, and he has had to clear about half a square mile for us. My next letter must be written there. The hospitalities of Bombay leave one but little time for serious and sustained mental exertion.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

MARCH, 1898.

No. 264.

ANNIVERSARY MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, February 11, 1898.

Sir R. S. BALL, LL.D., F.R.S., *President*, in the Chair.

Acting Secretaries: E. B. KNOBEL and F. W. DYSON, M.A.

Mr. Dyson read the Minutes of the last Anniversary Meeting, which were confirmed.

Mr. R. Inwards read the Report of the Auditors, which stated that they had examined the Treasurer's accounts for the year 1897 and certified the same to be correct. The cash in hand on 1897 Dec. 31 was £244 11s. 2d., as compared with £201 17s. 6d. on 1897 Jan. 1. They had inspected the books and other property of the Society, which appeared to them to be in good condition.

Mr. Knobel read extracts from some of the obituary notices which had been prepared on behalf of Fellows and Associates of the Society who had died during the year. The list of these included the following names:—Antoine d'Abbadie, J. W. Aldridge, J. T. Barber, Adolphe de Boe, F. Brodie, L. P. Casella, H. B. Chamberlin, J. J. Cole, Samuel Cottam, Rev. J. E. Cross, Rev. Alex. Freeman, William Godward, Adam Hilger, Joseph Maguire, Albert Marth, J. C. Robertson, W. Roxburgh, Commander J. M. Share, C. Stewart, E. J. Stone, W. R. Vines, C. C. Walker, who were Fellows; and Wilhelm Döllén and F. A. T. Winnecke, Associates.

Mr. Dyson gave the heads of the notes on the progress of astronomy during the past year which were included in the Report of the Council. The subjects of these notes are:—Discovery of Minor Planets and Comets, Meteoric Astronomy, Prof. Barnard's Planetary Measures, Solar Activity, Double Stars, Variable Stars, the publication of Poincaré's '*Mécanique Céleste*'

and Prof. Darwin's 'Researches on Periodic Orbits,' Dr. Gill's publication of his determination of Solar Parallax, Star Catalogues, the Variation of Latitude, Spectroscopic Researches, a new Determination of the Longitude of Madras, and the opening of the Yerkes Observatory.

The President. Gentlemen: It is the duty of your President at these Annual Meetings of the Royal Astronomical Society to deliver an address on a very important subject. I allude to the award of the Gold Medal which is conferred annually by the Society on some astronomer who has rendered distinguished service to our science. The discharge of that duty is perhaps the most responsible official act that devolves on the occupant of this Chair. The Council has this year awarded the Medal to Mr. W. F. Denning for his cometary discoveries, his planetary observations and his researches on meteors, and I will now set forth to the Society the grounds for the award.

At the conclusion of his address on the astronomical career and work of Mr. Denning, the President expressed his regret that Mr. Denning, through ill-health, was not able to be present that day, and handed the Medal to Mr. Knobel to be by him transmitted to Mr. Denning in recognition of his valuable work.

Dr. Rambaut proposed, and *Admiral Sir E. Ommaney* seconded the proposition, that the Report now read be received and adopted, and that it be printed and circulated in the usual manner, together with the Report of the Auditors and the President's Address.

The President appointed Prof. Herschel, Mr. McClean, and Rev. F. Howlett, Scrutineers of the Ballot.

The Ballot was then proceeded with, and the following gentlemen were elected to serve as Officers of the Society for the ensuing year:—

President: Sir R. S. Ball. *Vice-Presidents:* Capt. W. de W. Abney, W. H. M. Christie (Astronomer Royal), Dr. A. A. Common, Dr. J. W. L. Glaisher. *Treasurer:* E. B. Knobel. *Secretaries:* H. F. Newall, Prof. H. H. Turner. *Foreign Secretary:* Sir William Huggins. *Council:* G. H. Darwin, Dr. A. M. W. Downing, F. W. Dyson, Capt. E. H. Hills, Major P. A. MacMahon, W. H. Maw, Capt. William Noble, Dr. A. A. Rambaut, G. M. Seabroke, Dr. E. J. Spitta, Dr. G. Johnstone Stoney, W. G. Thackeray.

Admiral Sir E. Ommaney proposed, and *Mr. McClean* seconded, that the thanks of the Meeting be given to the Vice-Presidents and other Members of the Council who now retire, for their services in promoting the objects of the Society.

On the motion of *Mr. W. Ellis*, seconded by *Mr. H. P. Hollis*, a vote of thanks was accorded to the Auditors of the Treasurer's accounts and to the Scrutineers of the Ballot.

The following gentlemen were elected Fellows of the Society:—

Samuel Cooke, M.A., Principal of the College of Science, Poona,
2 Mortimer Road, Clifton, Bristol.

Thomas Charlton Hudson, B.A., Nautical Almanac Office, 3 Verulam Buildings, Gray's Inn, W.C.

David Hunter, John o' Groat's Villa, Cambuslang, Glasgow.

Edmund Taylor Whittaker, B.A., Trinity College, Cambridge.

Walter Wickham, Radcliffe Observatory, Oxford.

The following Candidates were proposed for election as Fellows of the Society:—

Capt. Vernon L. D. Broughton, Hillside, South Godstone, Surrey (proposed by Duncan Forbes).

Charles Friswell, 34 Madeley Road, Ealing, W. (proposed by J. McCarthy).

Prof. C. J. Joly, M.A., Astronomer Royal for Ireland, The Observatory, Dunsink, Co. Dublin (proposed by A. A. Rambaut).

William Ritchie, 75 Morningside Road, Edinburgh (proposed by W. Peck).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE third ordinary Meeting of the current Session of the British Astronomical Association was held at Sion College on Wednesday, the 26th January, the President, *Mr. N. E. Green*, in the Chair.

Nine new members were elected, and the names of eight candidates were read and suspended.

Mr. Goodacre read a paper by *Mr. Godden* on "The Partial Eclipse of the Moon on Jan. 7 last," and also the report of the Lunar Section on the same eclipse. All the observers agreed that the penumbra was very faint, and all except the Director (*Mr. Goodacre*) saw the eclipsed limb of the Moon through the shadow.

A paper by *Miss Brown*, on "The Remarkable Group of Sun-spots in December 1897," was then read, and was followed by a paper on "The Protrusion of the Umbra and the Law of Refraction" by the *Rev. Arthur East*. *Mr. East* said it not infrequently happened that when a sun-spot was viewed near the edge of the Sun, and when the umbra ought to be far down out of sight, hidden by the nearer edge of the spot, on the supposition that the spot was a saucer-shaped depression, with the umbra for its bottom, the black umbra still seemed to be on a level with the top of the spot, proving, apparently, that the umbra could not really be the bottom of a cavity, or if the bottom, that it must be a bottom so convex that it showed at the top of the spot when the latter was seen in profile. The writer then proceeded to argue that this phenomenon was exactly what ought, according to the law of refraction, to occur, even were the cavity a deep one, assuming it to be filled with denser vapour.

Mr. Adams thought *Mr. East's* theory a very pretty one, but

doubted whether it was adequate to account for all the phenomena in question.

Mr. Rendell asked whether it was probable that any vapour on the solar surface was sufficiently dense to produce the refraction supposed.

The President thought that some of the metallic vapours might probably be sufficiently dense.

Mr. Holmes read some remarks in criticism of *Mr. Hopman's* paper on "Dark Meteors." He maintained that all the phenomena described were equally consonant with a purely terrestrial origin, and might be either birds, insects, or seeds seen out of focus. He ridiculed the idea of any of them having an observed rotation.

Mr. Goodacre explained the construction and working of a simple form of driving-clock based upon an invention of the late *Mr. Vallance*.

Mr. & Mrs. Maunder contributed a paper giving the results of their observations of the Zodiacal Light during their voyage out to India. Observations were made on the evenings of December 22, 23, and 24 for the evening portion of the light, and on the morning of December 28 for the morning portion. The glow was very distinctly seen in its lower portion earlier in the evening than the Milky Way could be made out. For quite 30° in length it was distinctly brighter than the Milky Way. After that it faded rapidly, and where it crossed the Milky Way between Taurus and Gemini, the Galaxy entirely overpowered it. When the light was first seen after sunset on December 22, it appeared almost to meet the Milky Way on the horizon; but the stars in Sagittarius were lost in the twilight. The paper then gave a list of stars defining the northern and southern borders, both for the evening and morning zodiacal light.

Mr. D. A. Drew, writing on Venus from Flagstaff Observatory, Arizona, U.S.A., stated that he used the 24-inch Clark equatorial with a $2\frac{1}{4}$ positive eyepiece, to which was attached a diaphragm with a 1 mm. aperture. He agreed with *M. Antoniadi* that many of the markings curiously followed either great circles passing through the cusps or small circles parallel to the terminator. But many other markings were found that were perpendicular to both these systems of circles, and a few that seemed to possess no symmetry whatever with respect to either limb or terminator.

The President remarked that the markings were very difficult to focus, but they were there. In years gone by he had tried earnestly to copy them, but found it so difficult that he had to give up the effort.

Mr. Holmes said they were not told the focus of the telescope, but he was not surprised at anything that was seen when looking through such a minute aperture.

The President said he had in his hand a letter from *M. Antoniadi* on the interesting question of the duplication of the canals of Mars.

The paper would appear in the Journal, and perhaps it would be well to postpone any discussion until Members had had an opportunity of reading it. M. Antoniadi was very strongly of opinion that the duplication of the canals of Mars was entirely the result of imperfect focussing, which might be less than one-hundredth of an inch.

In the discussion which followed, it was urged that duplication might be caused by imperfect focussing or by eye-fatigue.

Mr. Holmes said that if an observer thought he ought to see lines duplicated, he would try always so to focus his instrument as to get that effect.

Dr. Downing referred to the recent solar eclipse, and said that he thought the Meeting should not disperse without an expression of pleasure at the good news they had received of the success of both the expeditions connected with the Association.

ROYAL METEOROLOGICAL SOCIETY.

THE Monthly Meeting of this Society was held on Wednesday evening, February 16, at the Institution of Civil Engineers, Westminster, Mr. F. Campbell Bayard, President, in the Chair.

Mr. E. Mawley, F.R.H.S., gave a Report on the Phenological Observations for 1897, from which it appeared that there had been a marked absence of very exceptional weather during the past phenological year, the most noteworthy features affecting vegetation being the persistent rains in March, and the three dry periods of May, July, and October. Until about the middle of May, wild plants appeared in blossom in advance of their usual time, but throughout the rest of the flowering-season they were all somewhat behind their average dates in coming into bloom.

The heavy rainfall in the early spring favoured the hay, which proved the only really abundant farm-crop of the year, but greatly impeded the sowing of spring corn. The cereals were, however, much benefited later on by the warm, dry, and brilliant weather of the summer. Taking the country as a whole, oats proved a good crop, barley an average one, while the yield of wheat was somewhat under average. There were also fair crops of roots and potatoes. It was owing more to the dry spring and summer and the sunless autumn of the previous year than to the moderate frosts and cold winds of the spring of 1897 that the fruit-crop was such a very light one. Apples, pears, and plums, and especially the latter, yielded badly, while the small fruits were in most districts only average crops.

Mr. Hopkinson, F.L.S., read a paper on "Monthly and Annual Rainfall in the British Empire, 1877-96." In this the author gave particulars of the mean monthly and annual rainfall, and the number of rainy days at the following twelve stations in the

British Empire, viz.: London; Port Louis, Mauritius; Calcutta and Bombay, India; Colombo, Ceylon; Adelaide and Melbourne, Australia; Wellington, New Zealand; Toronto and Winnipeg, Canada; Kingston, Jamaica; and Malta.

Some Descriptions of the recent Eclipse.

THE Indian mail which arrived on February 13 brought full information from the eclipse parties and graphic accounts of the scene. The results obtained by some of the expeditions will be found in the Notes at the end of this number. We reprint here some descriptions from various sources.

At Viziadrug.

"But high overhead was a sight it was worth a journey of thousands of miles to see. In the midst of the dull blue sky stood out the inky blackness of the Moon with its slightly ragged edge, a silhouette more sharply defined than the mind can conceive. Encircling the Moon was the corona, a mass of the purest and most brilliant incandescence, thin in the upper portions, and much broader below. On the lower left corner a blazing blood-red prominence cast a ray of beautiful colour into the dazzling whiteness, a smaller and less conspicuous spot appeared upon the opposite quadrant. At the second of totality four extensions leapt from the corona into the surrounding darkness, feathery, ethereal streams of the most exquisite pearly luminosity. To the southward Venus shone with the brilliance of a tropical night; below her Mars less clearly, and three stars of lesser magnitude were barely visible. The darkness, owing to the great clearness of the atmosphere, was not intense. Newspaper print could be easily read, or the position of the second hands of a watch noted without the assistance of a lantern. Still the landscape presented an unnatural appearance, and irresistibly suggested a world seen through a coloured glass. Away to the westward the horizon was a dull grey-purple, shading into a delicate violet, and then to a lovely subtle yellow like the tinge of an English winter sunset; to the east the shadow of the Moon seemed to envelop the Earth like an angry rain-cloud. There were few opportunities of observing the effects of the eclipse upon the animal world. A number of crows circled restlessly over the trees which fringe the little sandy bay; a big yellow snake half crawled out of his hole near the wall, looked round, and withdrew. Other sign of animal life there was none." (From the 'Times of India.')

At Jeur. A Lady's Account of the Eclipse.

"It was just about 5 A.M. and quite dark when we reached Jeur. It is quite a small station and we looked about in vain

for a cloak-room or a porter. When the Sun was up we all dispersed in groups to explore the place. It is a picturesque village, surrounded by good stone walls. Excursion trains came in every half-hour; among the visitors were the Governor of Madras and the Gaikwar of Baroda. We found everything beautifully arranged for breakfast. Large tents had been erected to hold 600 people. After breakfast we went to choose a nice place for watching the eclipse. We chose a bridge under some shady trees, where we could sit in the shade and run out from time to time. We observed the first contact and our excitement was growing, but the Moon seemed to come on very slowly, and it was an hour before we noticed any change in the light or heat; then a cool breeze sprang up and some ladies sent for shawls. . . . For 20 minutes before totality there was a very weird light over everything. I watched 4 cows sleeping below the bridge, and one got restless and excited just before totality. The natives gathered in groups, and we invited them to look through our coloured glasses, which at first they were frightened to do.

"The moment of totality was very solemn; I heard a distant shout from the crowd and then perfect silence. I noticed 3 rays in the corona, the longest downwards towards the right, the other two upwards towards the left, but there may have been other smaller ones.

"It was not total darkness by any means; there was a sort of blue moonlight effect. I did not notice the shadow coming, as I was watching the sky changing colour; round the horizon it was yellow, and above greyish blue. It was very beautiful. There has not been a single cloud in the sky for more than a month.

"I saw 2 stars only: Venus, I suppose, was one. We all felt a little flat when the Sun reappeared only too soon, and we went to refresh ourselves by a good luncheon."

At Talni.

"Mr. Smith, the occupant of the most easterly of our huts, warned us of the commencement of the eclipse at nine minutes before noon, when the first slight indentation appeared on the south-west limb of the Sun. The hour and a half that followed seemed to pass with exceeding slowness. Gradually the dark Moon crept over the bright face of the Sun, and as it advanced seemed so much smaller than the Sun—increased in appearance from the effect of irradiation—that one might have been forgiven if a momentary fear had seized one that the statement circulated by the Brahmins among the natives was correct, and that the eclipse would not be quite total after all. The Moon, however, kept on her way, and, as the eclipse drew near to fulness, seemed to quicken her pace. The brighter colours faded from the landscape, the sky became leaden, the grass and trees turned to ink,

and the intense heat of the earlier morning gave way to what the travellers from England at least regarded as a refreshing coolness. Then the event came on apace. The last thin crescent of sunlight melted away at either horn, a few fine globules of light fought for an instant against the approaching darkness, were swallowed up, the shadow swept up and covered us, and the eclipse was complete.

"For us at Talni the eclipse lasted eight seconds short of two minutes—four seconds less than we had expected. But during that short two minutes what a number of impressions we were receiving over and above the attention which had to be given to the actual work on which we were engaged! The corona itself, though it claimed chief notice, was not the only object before us. The chromosphere, with its peculiar flame-like rosy light, seen first on one side of the Moon, then on the other; the prominences, the largest of which burned like a ruby on the south-east limb; and Venus, clear and serene—noticed even during the partial phase some half-a-dozen degrees distant to the south-west—all added to the beauty of the scene. Mars, further away still in the same direction, and two or perhaps three stars, could also be detected, though fainter far than Venus. But during the whole progress of the eclipse we were sensible of the shrill cries of the distant and unseen villagers, as, to their distress, they saw the demon of the darkness overpowering their beloved divinity. The cries of the villagers sank to silence as the totality reached its full depth; then when the Sun shot forth his first rays a glad shout of welcome went up from the village, and a loud Hurrah! from the group of European spectators in the camp, while the astronomers exchanged congratulations more quietly, their delight at such perfect conditions for their work mingled with a sort of wonder that the event on which their thoughts had centred for so long had passed, and passed so swiftly." (The 'Daily Graphic,' Feb. 15.)

A correspondent of the 'Times of India' gives the following observations of shade temperature at Bombay during the eclipse. The thermometer was suspended about four feet from the ground in the shade of a tree at Malabar Hill:—

Bombay		Temp. F.	Bombay		Temp. F.	Bombay		Temp. F.
Time.			Time.			Time.		
h	m		h	m		h	m	
11	7..	84°0	12	25..	76°0	1	10..	72°0
11	20..	84°0	12	30..	76°0	1	20..	74°0
11	25..	84°0	12	35..	75°0	1	30..	75°0
11	35..	83°0	12	40..	74°0	1	40..	76°0
11	40..	82°0	12	45..	72°0	1	55..	78°0
11	50..	81°8	12	55..	72°0	2	5..	80°0
Noon	..	80°5	1	0..	72°0	2	15..	80°0
12	12..	78°0	1	5..	72°0	2	20..	80°0
12	18..	78°0						

Periodic Orbits.

PROFESSOR DARWIN has just published, in the 'Acta Mathematica,' the results of three years' investigations in the Problem of Three Bodies. This problem has been occupying the attention of mathematicians since the time of Newton, but, although the cases presented by Nature have been solved with a high degree of numerical accuracy, little is, however, known about the general features of the problem. The methods of research, however, have been revolutionized during the last quarter of the century by Dr. Hill, in the first place, and following on his lines by M. Poincaré, Gylden, and others.

The most interesting case presented by Nature, of one body moving under the combined influence of two others, is that of the Moon; for although in the motion relative to the Earth the influence of the Earth is predominant, nevertheless the disturbance caused by the Sun is many times greater than the disturbance due to the action of any one planet upon the motion of any other.

There are six principal inequalities in the motion of the Moon. Firstly, the elliptic inequality, whereby the Moon oscillates between two extreme distances from the Earth in the ratio of nine to ten nearly; and whereby it is alternately in front of and behind its mean place by as much as six degrees; secondly, the inclination, by which it oscillates from side to side of the ecliptic. These are by far the largest inequalities. Thirdly, there is the variation, owing to the action of the Sun, whereby the Moon is nearer to the Earth, and is moving faster in syzygies than in quadrature; and closely allied to this the parallactic inequality due to the fact that the Moon is nearer to the Sun by the whole diameter of its orbit when new than when full. Fifthly, there is the evection due to the varying influence of the Sun relatively to the action of the Earth as the Moon gets further from and nearer to the Earth in its elliptic motion; and, sixthly and lastly, among the greater inequalities, the annual equation due to the fact that the Sun is nearer to the Earth in January than in July, and its influence correspondingly greater. Now, the last four of these six inequalities are comparatively insignificant as compared with the first two; but there is this great distinction between the first two and all others. The other inequalities are all due to the action of the Sun: the Sun is the visible cause of their existence, and we cannot conceive their non-existence except by supposing the absence of the Sun, when the problem would be not one of three bodies, but of two. No doubt there is a cause also for the elliptic or inclinational inequalities; but the cause is unknown, and to be sought for in some previous state of evolution ages ago; we not only can conceive the absence of these inequalities, but it affords us great assistance to do so. Were the Moon's course slightly disturbed, there would be a variation; there might possibly be no elliptic inequality or inclination.

What, then, are these inequalities? They are oscillations about the path that might have been described if the Moon were projected a little differently. Now the above-mentioned revolution in the lunar theory introduced by Dr. Hill is contained in the recognition of this fact. It is true that the best simple description of the Moon's orbit is to say that the Moon moves in an ellipse, and that this description suffices for accuracy to within a degree, and is ten times more accurate than to say that the Moon moves very nearly as if it had no eccentricity or inclination, in an oval slightly elongated in quadrature, but the less accurate approximation at the outset is by far the most convenient mathematically. Let us take as an illustration the explanation offered from the two points of view of the motion of the apse or node. The disturbed elliptic motion theory has an elaborate explanation to offer as to why the apse, for instance, which is at rest in undisturbed motion, rotates owing to the Sun's motion. The new method regards the eccentricity as an oscillation, and the time from perigee to perigee as the time of an oscillation. The statement is, therefore, that the time of an oscillation is different from the time of a sidereal revolution. Such a proposition hardly requires to be defended. Who, for instance, would suppose that a top wobbling, that is to say, with its axis rising and falling, would take exactly as long to make one wobble as it would take to turn once round on its axis, or for its axis to make one revolution round the vertical?

The lunar theory will for the future, then, be presented thus:—If the Sun's orbit round the Earth had no eccentricity, the Moon might have moved in such a manner as to return once a synodic month to exactly the same relative position that it had before. Superposed on this periodic motion there is an unavoidable inequality due to the inequalities in the Sun's motion, and further inequalities, that might have been absent, due to what are called the Moon's eccentricity and inclination. Obviously, therefore, information must now be collected about periodic orbits, which present, according to M. Poincaré, the most hopeful road to progress in the future.

M. Poincaré has published some results of a general character obtained by advanced methods of pure mathematics, but the first extensive results in a concrete form are contained in Professor Darwin's recent paper.

To exaggerate the inequalities so as to make it possible to represent them on a diagram, Professor Darwin has supposed the mass of the second body, which he calls Jove, to be one-tenth of that of the Sun. As he is not concerned with the forced oscillations that would arise from an eccentricity in the motion of Jove round the Sun, he supposes such motion to be circular; and for simplicity he assumes that the mass of the third body is negligible so as not to disturb the two first. The two principal bodies are therefore represented as fixed points in a plane revolving uniformly with the orbital motion of the two bodies round each other. In such cases as are met with in Nature, the

third body is under the predominant influence of one or the other body, or it is far away from both; in physical language, it is a satellite, or an inferior planet, or a superior planet. Professor Darwin has considered cases where the third body, starting in the neighbourhood of Jove, passes nearly, and in some cases quite, out of the region where Jove's influence predominates; that is to say, he has limited his investigations to satellites that have a tendency to pass away from their planets and become inferior planets. This of course is only dealing with a very small portion of the field that the methods of calculation that he has invented have opened up.

The orbits that have been obtained are full of interest, and, as Professor Darwin says, presented a succession of surprises. Some have cusps, others have loops, others resemble figures of eight. Some enclose Jove, others enclose the points of equilibrium between the Sun and Jove and beyond Jove. It is interesting to see how the orbits gradually change. In one case a slight hump indicates the beginning of the development of a cusp. Unfortunately, Professor Darwin's methods only allow of calculations of orbits at finite intervals from each other. During the interval some change has perhaps taken place; a simple loop, for instance, has become a figure of eight. It is not known at present how this transition took place, and until this point is cleared up the results will be interesting but disjointed.

P. H. COWELL.

*Notes on some Points connected with the Early History
of the 'Nautical Almanac.'*

[Continued from p. 53.]

FROM an examination of the Minute Books and other records of the now extinct Board of Longitude, preserved at the Royal Observatory, I have found several interesting references to the administration, or business matters, relating to the computers, some of which clearly show that scientific work in those days, however valuable it may have been to the nation, was not likely to lead the unfortunate computers to fame or fortune. Indeed there are numerous evidences preserved in these MSS. from which may be inferred that a general dissatisfaction existed among the computers in consequence of the irregular periods of payment of their moderate stipends*. This neglect on the part of the Board, especially after its Secretary had the superintendence of the Almanac, was evidently a source of great anxiety to them, as

* [In the Minutes of the Board of Longitude there are preserved various letters from the computers asking for payment of overdue salaries. It is a little curious that in one of these, from Mr. William Dunkin, the writer states that the reason for his wanting money is that his domestic responsibilities have been added to by the birth of a fine boy. The "fine boy," whose advent is thus recorded in these official and historical volumes, was afterwards the author of these notes, Mr. Edwin Dunkin.—Eds.]

the arrears occasionally extended over two years before a complete settlement could be obtained. In addition to these untoward delays in the payment of their stipends, the computers felt no certainty in the permanence of their employment, and as a consequence many of them were compelled to undertake other occupations to obtain the means of livelihood. Even Malachy Hitchins was deeply concerned at one time about this absence of permanency, as in 1793 there appeared to be some prospect of his losing his position as comparer altogether, or at any rate for several years. This arose from the circumstance that, owing to the advanced state of the computations, the Board of Longitude had under their consideration a proposal to discharge the computers, and to suspend all the calculations of the 'Nautical Almanac,' on the grounds that as the Almanacs were then computed to the end of 1804, or ten years in advance, it would be important to include in the volumes after 1804 any improvements that might in the meantime be made in the solar or lunar tables from which the Almanac was computed. It was ultimately resolved by the Board to suspend the calculations during the next five years. The wisdom of this resolution, in a scientific point of view, was manifest to the majority of the members of the Board, who expected that, in the interval of suspension, some progress would certainly be made in the construction of improved tables, and thus a more accurate exhibition of the tabular places of the Sun and Moon might be given in the Almanacs for 1805 and subsequent years.

This resolution naturally created a great consternation among the computers. Memorials were accordingly submitted to the Board of Longitude from Mr. Hitchins and others, two of whom asserted that they had little or no means of living. One, a Mr. Henry Andrews*, stated that "a total discontinuance of the calculations, and at the same time make no compensation for the disappointment," would cause him to "sustain on that account a very great loss, as it has of late years been the chief part of his livelihood and support." The following very characteristic memorial of Mr. Hitchins represents clearly the general feeling of all the computers:—

To the Honourable the Commissioners appointed by Acts of Parliament for the discovery of the longitude at sea, &c. The Petition of Malachy Hitchins, clerk, humbly sheweth,—

That having been employed for twenty-six years† past by the Hon. Board of Longitude in computing and revising the 'Nautical Almanac,' in which he has discharged his duty with the greatest fidelity, according to the best of his abilities, and he flatters himself to the satisfaction of his

* [Mr. Dunkin has in his possession an old print of Mr. Henry Andrews. On this it is stated that he was "Astronomical Calculator to the Board of Longitude, and the celebrated Author of 'Moore's Almanac.'" —Eps.]

† This memorial was presented to the Board of Longitude in 1793. The year in which Mr. Hitchins was first employed on the calculations must therefore be 1767, or possibly the latter part of 1766.

honourable employers, he is sorry to find that he is now suddenly and unexpectedly to lose his appointment for seven or eight years to come, and perhaps for ever. He begs leave to represent to the Hon. Board that on a presumption that he should be continued in the same situation as long as he deserved their confidence by properly executing the trust they kindly reposed in him, he discharged some private pupils for whose education he was liberally paid, and refused others that were offered him, that he might give his whole time to the computations of the ephemeris. On the same supposition of a permanent engagement, he also computed a great number of new tables, and enlarged many old ones for expediting the calculations of the ephemeris, all of which will now be of no further service, though their construction cost him, at different times, much more than a half-year's close application. For these and other reasons which might be adduced, were it not for fear of intruding too much on the time and attention of the Hon. Commissioners, he humbly requests that the Hon. Board will condescend to take his case into consideration, and either reduce the number of years in advance by letting the computers have one year to finish in the space of two or three, or make him such compensation for his loss and disappointment as they, according to their wonted liberality, shall think meet; and their Petitioner will ever pray, &c.

MALACHY HITCHINS.

It is gratifying to know that these memorials received every sympathy from the members of the Board, and that other astronomical work was found, which was probably sufficient to fully occupy the time of the computers during the suspension of the ordinary calculations. I think that we can infer that this was the case from the following extract taken from the Minute-Book of the Board, dated December 7, 1793:—

The Astronomer Royal called the attention of the Board to what he had mentioned at the last meeting, respecting the 'Nautical Almanacs,' which were now computed to the end of 1804, or ten years in advance, and submitted to their consideration whether it might not be proper to discontinue the calculations of them for some years to come, agreeably in a proposal from Dr. Hornsby, that if any improvements are made in the tables from which the Almanacs are now computed, they might be adopted. The Board admitted the propriety of stopping the calculations for the 'Nautical Almanac' for some time, and resolved they should be discontinued for five years.

Petitions from the computers, Mr. Henry Andrews, Mrs. Mary Edwards, and the Rev. Malachy Hitchins, were then read, representing the great loss they should sustain, if after having made the computations for twenty-six years, they are deprived of an employment from which they derive their support, and on which they have been accustomed to depend, without having received any notice till lately of this unfortunate event to them being likely to take place, and praying for such relief as should be found meet.

After some discussion the Board resolved, on the recommendation of the Astronomer Royal, to employ the computers on extra computations during the next five years, particularly with regard to the comparison of the results of these calculations, made with Lalande and Mason's new tables of the Moon, with the observations that have been made at the Royal Observatory since the establishment of the new instruments by Dr. Bradley in 1750, and "that the computers should be paid at the same rate as at present, according to the quantity of work they should do" *.

* Royal Observatory MSS., Class A, Shelf B, No. 418.

It is only necessary to remark further that the suspension of the ordinary calculations turned out, as was expected, to be advantageous to the character of the work, as it enabled the employment of several improved methods in the computation of the Almanacs after 1804. All the old computers were in due time restored to their usual amount of work, and the Almanac in future was issued about four or five years in advance. After the death of Mr. Hitchins the office of comparer was left in abeyance for two years, when, in 1811, the Rev. Mr. Brown, of Tideswell, Derbyshire, was appointed by the Board of Longitude to succeed him. During this interval the duties of the comparer were assigned to those of the computers who had the most experience in the calculations.

Before closing these notes I think I ought to refer to the connection of the Rev. Malachy Hitchins with the staff of the Royal Observatory, when he assisted in observing the transit of Venus and in making other astronomical observations, all of which may be found recorded in the volume of '*Greenwich Observations*' for 1769.

When Dr. Maskelyne went to St. Helena in 1761 to observe the transit of Venus and other astronomical phenomena, Dr. Bradley, who died in 1762, was the Astronomer Royal, and at that time Dr. Maskelyne had no official connection with the Royal Observatory. Dr. Bradley was succeeded by Dr. Bliss, who died in 1764, and Dr. Maskelyne was appointed Astronomer Royal in the beginning of 1765, shortly after which Mr. Hitchins came to Greenwich for a time to take part in the calculations of the new ephemeris. At the request of the Council of the Royal Society, Mr. William Bayley, Dr. Maskelyne's sole assistant, was sent to the North Cape to observe the transit of Venus of 1769, and during his absence of several months, Mr. Hitchins took his place at the Observatory, and observed daily with the meridian instruments, from about the middle of April to near the end of July, and on June 3rd he was one of the observers of the transit of Venus*. During any temporary absence of the Astronomer Royal, he was most likely entrusted with the charge of the Observatory till the return of Mr. Bayley, when it would appear that his astronomical observations ceased. In Dr. Maskelyne's account of the Greenwich observations of the transit of Venus, he refers to Mr. Hitchins as a "gentleman well acquainted with astronomy and astronomical calculations, who has made and examined many belonging to the '*Nautical Almanac*,' and has been so obliging as to come here and assist me in making astronomical observations during the absence of my assistant, who is

* The transit of Venus of June 3rd, 1769, was observed at the Royal Observatory by Dr. Maskelyne, Mr. Hitchins, and five other observers who came to Greenwich for the special purpose of observing the transit. Mr. J. Bradley, nephew of Dr. Bradley, and formerly an assistant at the Royal Observatory, was also sent by Dr. Maskelyne into Cornwall, where he observed the transit successfully at the Lizard.

gone to the North Cape, by appointment of the Royal Society, to observe the transit of Venus there" *.

Of Malachy Hitchin's four sons, one only appears to have been connected in any way with his father's scientific pursuits. I believe that he assisted his father occasionally in the calculations of the Almanac. With reference to the remark made in Gilbert's 'Cornwall,' vol. ii. p. 224, and in Lake's 'History,' vol. ii. p. 138, that this, the third son, William Malachy, "filled the office for some time that his father had occupied at the Royal Observatory," I find recorded in the Observatory MSS. that his service lasted only about eleven weeks, from April 8 to June 22, 1787, when he was about seventeen years of age.

EDWIN DUNKIN.

The Variable Star U Pegasi †.

MUCH difficulty has been experienced in determining the nature of the variations in the light of this star. Mr. Chandler states that he at first supposed that it was a star of the Algol type having a period of $2^d.06$ or $2^d.07$. It was then observed by Mr. Yendell, who confirmed the variability and still regarded it as of the Algol type, but with a period of $0^d.69$. Mr. Chandler, under date of October 26, 1895, announces in the *Astron. Journ.* xv. p. 181, that the period is $5^h 31^m 9^s.0$, which "is probably only a moderate fraction of a second in error," that it is not of the Algol type, but that the times of increase and decrease are equal. Mr. Yendell (*Astron. Journ.* xvi. p. 78) states that the time of increase varies from $1^h 28^m$ to $3^h 41^m$. Again, Mr. Chandler (*Astron. Journ.* xvi. p. 107) announces that the period is $5^h 32^m.25$, that it is perfectly regular, and that previous discrepancies are due to a large subjective error amounting to $0^m.6p$, in which p is the parallax angle. The correction for this error will sometimes increase and sometimes diminish the observed time of minimum by as much as half an hour. He also states that the decrease in light is more rapid than the increase, and, referring to the short period variables Aquilæ and δ Cephei, that "we may therefore regard U Pegasi provisionally as a type of variability distinct from this class of stars, as it evidently is from those of the Algol type."

Owing to these uncertainties it seemed desirable to determine the true form of the light-curve photometrically, especially as such observations are free from the subjective error mentioned above, since the images compared are constantly interchanged. Assuming the light-curve to be constant, it appeared possible to determine its form from observations made during a single evening. Accordingly

* Phil. Trans. vol. lviii. p. 36c.

† This account of recent observations of this interesting variable, supposed hitherto to have a shorter period of variation than any other (see 'Observatory,' 1896 January, pp. 65, 70), is a reprint, with some excisions, of Harvard College Circular No. 23.

measures were made by Mr. O. C. Wendell with the polarizing photometer (Astrophys. Journ. ii. 89) attached to the 15-inch equatorial telescope of the Harvard College Observatory. The results for a single evening, December 28, 1897, are contained in the annexed table, the first column giving the Greenwich Mean Time, and the second the photometric magnitude found by adding the observed difference in magnitude between *U Pegasi* and the comparison star, $+15^{\circ}4916$, to 8.90 , the photometric magnitude of the latter star. The third column gives the residuals found by subtracting from the magnitude given in the second column that derived graphically from all the observations.

Observations on December 28, 1897.

G.M.T.	Magn.	O-O.	G.M.T.	Magn.	O-O.	G.M.T.	Magn.	O-O.
h m			h m			h m		
10 26.9	9.63	.00	12 41.2	9.32	+ .01	14 50.0	9.65	.00
10 34.2	9.56	-.01	12 51.1	9.36	+ .03	15 7.0	9.56	+ .03
10 42.2	9.52	+ .01	13 17.4	9.43	+ .01	15 15.0	9.48	.00
10 55.3	9.48	+ .02	13 27.2	9.46	-.01	15 21.0	9.42	-.02
11 4.7	9.43	+ .02	13 36.0	9.56	+ .03	15 26.8	9.42	.00
11 12.4	9.36	-.02	13 48.7	9.60	-.01	15 33.2	9.42	+ .04
11 31.3	9.32	-.01	13 58.6	9.67	-.02	15 56.9	9.34	.00
11 40.0	9.33	+ .02	14 17.5	9.78	+ .04	16 3.0	9.37	+ .02
11 48.6	9.30	.00	14 24.5	9.77	+ .02	16 13.3	9.35	+ .01
11 55.4	9.27	-.02	14 34.0	9.75	+ .02	16 21.2	9.38	+ .04
12 25.8	9.30	.00	14 43.0	9.75	+ .07	16 29.6	9.34	.00
12 33.4	9.28	-.02						

It is obvious from an inspection of these observations that the star had nearly the same brightness after an interval of $4^{\text{h}} 30^{\text{m}}$, at first indicating that the variable had this period and not $5^{\text{h}} 31^{\text{m}}$. But later observations showed that the phenomena were not quite so simple. Assuming the period $4^{\text{h}} 30^{\text{m}}$ it soon appeared that the even minima were fainter than the odd. Observations continued through even minima on four nights gave the minimum brightness of *U Pegasi*, including errors of observation, 9.94 , 9.94 , 9.92 , and 9.85 respectively, while corresponding measures of odd minima gave the magnitudes 9.78 , 9.78 , and 9.75 . It thus became evident that the period should be doubled, and plotting the observations a light-curve was formed closely resembling that of β Lyræ. The formula $J. D. 2413514.6157 + 0^{\text{d}}.37478E$ has been adopted, which closely represents the observations recently made, and also a few less accordant observations made here in 1895. Changing the period by two seconds, to $0^{\text{d}}.3748$, would alter the times of minima in 1895 by about an hour, while the uncertainty is only a small fraction of this amount. The period may, therefore, be assumed to be $8^{\text{h}} 59^{\text{m}} 41^{\text{s}}$. The magnitude at maximum is 9.30 , at primary minimum 9.90 , and at secondary minimum, 9.75 .

If we neglect the difference between the primary and secondary minima, reduce the half-period to fractions of a day, and multiply it by 16 we obtain the product $2^d.99824$, or very nearly three days. Therefore, the phases recur at nearly the same times every three days. If we multiply the period $5^h 32^m 15^s$ by 13 we obtain $2^d.99948$, or very nearly the same quantity. In either case, therefore, the phases would recur at the same times every three days, but with the second period the interval between successive minima would be greater than with the first period in the ratio of 16 to 13.

From the above discussion it appears that U Pegasi is no longer the variable star having the shortest period known. This position appears to be held by the variable ω Centauri 19, discovered by Professor Bailey, who finds its period to be $7^h 11^m$. Although U Pegasi can no longer be regarded as an example of that peculiar class of short-period variables having a single maximum, in which the decrease is more rapid than the increase, this class is still represented not only by S Antliæ, but by ω Centauri 24, which Professor Bailey finds to decrease twice as rapidly as it increases, while ω Centauri 45 increases at least five times as fast as it diminishes.

EDWARD C. PICKERING.

January 14, 1898.

[Since the above has been in type we have received No. 426 of the *Ast. Journ.*, in which Dr. Chandler contests Prof. Pickering's conclusion. He thinks that the above is an overstrained interpretation of Mr. Wendell's observations, and that the photometer used does not permit of observations sufficiently delicate to form a satisfactory basis for Prof. Pickering's inference. Dr. Chandler thinks the period is $4^h 29^m.8$, with a simple and symmetrical light-curve.—EDS.]

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Atmospheres upon Planets and Satellites.

GENTLEMEN,—

A scientific friend has directed my attention to the last "paragraph" in the January number of the 'Observatory,' which purports to be a criticism of my recent memoir 'Of Atmospheres upon Planets and Satellites.'

The critic states that there is nothing new in the memoir but its arithmetic—a mistake which is not altogether explained by his subsequently informing your readers that he has read only one page of it. As he sees nothing beyond its arithmetic, he not

unnaturally insists on the absurdity of deducing a , the attraction of a planet, from g , the value of gravity at its equator, *because the numerical difference* (in the case of the Earth) *is small*—apparently not being aware that for the purpose in hand, viz., for the calculation of potential, it would be dynamically incorrect to employ g . It is on this account, which my arithmetical critic has failed to appreciate, that the correction needs to be applied, a necessity which is quite irrespective of whether the numerical change is small, as it is on the Earth, or large, as it is on some of the other planets.

His other criticisms are equally short-sighted. In making them he passes over everything except the mere arithmetic of the astrophysical problems dealt with, and takes no notice of the conditions which must be complied with if we would make the physical investigation sound—conditions which make it necessary to apply to the data furnished by observation those corrections, whether they happen to be arithmetically small or large, which will convert them from physical quantities, which it would be dynamically incorrect to employ, into those which the correct handling of the science of dynamics requires.

Even if we were content to occupy my critic's mistaken position and to limit our view to mere arithmetic, he would still be wrong; for when presenting a new arithmetical inquiry involving a quantity imperfectly determined associated with others the values of which are known, it is of importance to adopt the most accurate values that are available for the latter, so as to ensure that any error in the arithmetical value of the final result shall be exclusively due to the uncertain element.

The next criticism upon my memoir is the result of my critic's not correctly interpreting ordinary English. "The strength of a wind" is the established phrase to use in the English language when speaking of its velocity, and is measured, both by the public and by meteorologists, in miles per hour. My critic confounds this with "the force of a wind," the idiomatic expression which it is proper to use if we want to indicate the wind's pressure against obstacles, which has to be measured in quite a different way—by the density of the air multiplied by the square of its velocity.

But my critic meets with a more serious fall where he attributes the retention by a celestial body of the constituents of its atmosphere to "the restraining power of gravity" upon it—the fact, on the contrary, being that gravity upon two celestial bodies might be identical, consistently with the one being able and the other unable to retain its atmosphere. In reality the event depends upon a dynamical quantity of quite different dimensions to gravity. One of the objects I had in view when writing the memoir was to prevent the repetition by scientific men of this dynamical blunder; but though my critic had my paper in his hands, he continues in it, and proceeds to tell your readers that "some thirty year ago Dr. Stoney explained the non-existence of atmosphere on the

Moon on *these* lines." This is another error. I never did fall into my critic's dynamical mistake. I am, Gentlemen,

8 Upper Hornsey Rise, N.
1898, January 28.

Very faithfully yours,
G. JOHNSTONE STONEY.

[The "paragraph" looks a little more disrespectful in print than was intended (I wonder whether it is as heinous to "speak disrespectfully" of the top of the atmosphere as it is proverbially of the Equator?), and would probably have been modified in proof had I not been absent from England, and unable to see the proof. But is the main point touched by Dr. Johnstone Stoney's letter above? The point is that to make elaborate calculations with approximate data is misleading. If we do not know the height of our atmosphere within a considerable margin it is useless to select a particular value, such as 200 km., and treat this as correct to three figures or more. The proper method is to give a table showing results for different assumptions, so that we may see where we are. We should then see, for instance, that it is useless to assume a "strong wind at the top of the atmosphere" when an alteration of some 20 km. in our assumed height of 200 km. will do as well.

To go into the other points raised by Dr. Stoney would require a lot of quotation from the originals, which seems scarcely worth while. Perhaps one example will suffice: and I will take that considered most serious by Dr. Stoney in the last paragraph of his letter. My original words were:—

"Dr. Stoney made the valuable suggestion some 30 years ago that the lighter constituents of a planet's atmosphere tend to escape, the tendency being greater for planets of small mass when the restraining power of gravity is consequently small."

Now this sentence is certainly incomplete; for I have not gone into the details of the method of escape: it was not necessary to do so in order to reach the point I was concerned with, and with which I was proposing to deal within the limits of a paragraph. But there is nothing wrong in it. The lighter constituents *do* tend to escape, though not directly because of their lightness. The use of the word "lighter" is careless; but the carelessness is Dr. Stoney's own: cp. his words on p. 309 of his paper:—"The other constituents of the Earth's atmosphere, such as nitrogen, oxygen, and carbon dioxide, have still *heavier* molecules. Accordingly none of these escape in sufficient numbers, &c., &c."

The latter part of my sentence is of course an addition to, and not an explanation of, the first part; perhaps as it stands this is not sufficiently clear.—THE ARITHMETICAL CRITIC.]

Periodical Comets due in 1898.

GENTLEMEN,—

As Mr. Denning, in his interesting article ("Notes on Comets and Meteors") in this month's 'Knowledge,' has included Swift's comet, 1889 VI., amongst those due to return in the present year,

perhaps a few words respecting it may be desirable. Discovered by Prof. Swift at Rochester, N.Y., on the 16th of November 1889, it passed its perihelion on the 28th or 29th of the same month. The latest observation obtained was made, I believe, at the Vienna Observatory on the 17th of January 1890. Prof. Zelbr published elliptic elements in *Ast. Nach.* No. 2944, in which he makes the period 6.9 years, but remarks that the orbit was considerably uncertain, and adds that he hoped (if leisure permitted) to extend his calculations over a larger arc. Apparently he was not able to carry out this intention; and the latest determination is that of M. Coniel, published in the '*Bulletin Astronomique*' for July 1896, and quoted in the '*Observatory*' for the following month (Vol. xix. p. 315). This gives the period 8.9 years (2 years longer than Zelbr's), and would bring the comet into perihelion again about the month of October in the present year. But M. Coniel considers the period uncertain to the extent of nearly a year, so that a return may take place either this year or next.

Tempel's first periodical comet was discovered on the 3rd of April 1867, observed again in 1873 and 1879. On the latter occasion it passed its perihelion on the 7th of May, the period being about six years. Since then it has not been seen. M. Gautier calculated that the attraction of Jupiter would have delayed the last appearance till 1892; but as the comet was not seen on that occasion, we must doubtfully look forward to its return some time in the present year.

Yours faithfully,

Blackheath, 1898, Jan. 24.

W. T. LYNN.

Conspicuous Spots on Jupiter.

GENTLEMEN,—

This morning, when I made my first drawings of Jupiter at this apparition, I remarked two very conspicuous spots in the north tropical zone at latitude $+15^\circ$, which is the same latitude where the two garnet-spots were seen in the years 1894-96. At the moment I felt convinced that these garnet-spots had reappeared, for the shape of these spots resembled them. Our micrometer being under repair, I *estimated* the position of the first spot at $17^h 9^m$ (Jan. 19) $= \lambda 293^\circ$, and that of the second spot at $18^h 9^m = \lambda 329^\circ$. The first spot was rather diffused and mouse-coloured—an oval of perhaps 5 degrees in length; the second one, of perhaps 10 degrees length, very much resembled the *violin-spot*, being composed of two connected components, of which the following was the larger, but the line joining the centres of the two components was more inclined to the equator than was the case with the violin-spot. The colour was a pronounced black, with a slight tint of red, like that of an uncut Bohemian garnet.

Computation showed me, however, that these spots are not reappearances of the old garnet-spots, but quite new ones. For, examining my observations ("*Jupiter-Beobachtungen 1895-96*," in

vol. lxiv of the 'Denkschriften' of the Vienna Imp. Academy), I found that the violin-spot would be in longitude 17° and the garnet-spot in longitude 147° now.

My next observations will, I hope, elucidate the rotation-period of these new spots; for the moment I have a suspicion that the second spot retards by about $0^{\circ}.34$ a day, because, according to a letter from Herr Fauth, he saw it on November 25 last in longitude 348° . It is true that he also saw it on December 31 in longitude 330° ; but if that be true, one must suppose an *irregular* drift such as was also observed by me in the case of the two garnet-spots.

Yours faithfully,

LUSSINPICCOLI, 1898, January 28.

LEO BRENNER.

OBSERVATORIES.

MELBOURNE.—“We desire again to direct your Excellency's attention to the fact that the Acting Government Astronomer has been unable to deal with the publication of the accumulated arrears of observations and their results for want of adequate assistance, nor has he been able for the same reason to keep up the work of star-charting and measurements to so forward a stage as is desirable.” The above extract from the Report of the Visitors of the Melbourne Observatory to the Governor of the Colony echoes the key-note of Mr. Baracchi's Annual Report to the Visitors. The Director suggests, and the Board approves of the suggestion, that the best and cheapest way to put the Melbourne Observatory in the efficient state that it deserves to be would be to employ young women or youths as temporary computers, as is done at Greenwich and other observatories.

The work done at Melbourne now is, first, observations with the transit-circle and the reductions of the same, the photography for the Astrographic Chart and Catalogue (the zone -65° to the south pole is allotted to this Observatory), the taking of photographs of the Sun on days when conspicuous spots are present, the time-service, rating of chronometers, and meteorological and magnetical observations, as well as the official business which is always present in a government observatory—a sufficiently comprehensive scheme remembering that, besides the Director, there are only five scientific assistants and a clerical assistant, who is also caretaker. The office of Chief Assistant is vacant, but the Director hints that this post will shortly be filled.

The transit-circle has been used chiefly for determining the places of the fundamental stars required for the Astrographic Catalogue, and with the help of the staff of the Adelaide Observatory the places of 2834 out of the 6000 required have been obtained. The plates for the Astrographic Catalogue have nearly all been taken, but the chart plates, which are exposed for 60

minutes at Melbourne, are very few. The measurement of these is not attempted. We must again congratulate the observer in this department, as we did last year, on his energy, for he was able, during the twelve months ending 1897 June 30, to expose 201 plates of different kinds. It appears that he works single-handed, and has to be in the office all day from 9 A.M. These 201 plates include those taken for adjustment and for deducing magnitude; the net result for the year is 57 chart, 67 catalogue plates.

The work of publishing arrears is much the same as last year. The great equatorial reflector is still lying idle, as perforce it must with the limited staff. It has, with the two other equatorials, been used on special occasions, and has been sometimes put at the disposal of visitors. Mr. Baracchi has, with some reason, tried to discourage the general public from seeking admission, but, in accordance with a long-standing privilege, he has had to admit 223 visitors on Wednesday afternoons, and 154 persons have visited the Observatory in the evening.

THE MAURITIUS OBSERVATORY.—The Annual Report, just published for 1896, of the Director of the Royal Alfred Observatory, Mauritius, has, in accordance with a revised plan of publication, been greatly shortened, many of the tables hitherto appearing in this report having been relegated to the volume of magnetical and meteorological observations, commencing a new series. On the 30th September, 1896, Dr. Meldrum resigned the Directorship of the Observatory, after 22 years' service, on account of failing health, and Mr. T. F. Claxton, formerly Chief Assistant, was appointed Director on December 10. The vacancy thus caused on the staff was not filled until 1897 March, when Mr. A. Walter, from Greenwich, was appointed to the post of Chief Assistant; but owing to the zeal of the assistants the work of the Observatory has not greatly suffered. Details are given relating to the adjustment of the various instruments, and it appears that, owing to the Observatory not having a suitable building for the transit instrument, observations of the Sun cannot be made during the months of November, December, and January, on account of obstruction. This is a matter which should be remedied at once, and may, perhaps, explain why this instrument remained unmounted from 1892 April 29 until 1896 July.

The meteorological instruments are all in good working order. The highest recorded temperature in the year was $90^{\circ}\cdot6$, the lowest $53^{\circ}\cdot0$, and the mean $73^{\circ}\cdot1$, being nearly the same as the mean value for the five preceding years. The rainfall for the year amounted to 68.17 inches, being 18.58 inches in excess of the average amount. The rainfall was excessive in February (25.94 inches in four days, producing heavy floods), and also in May, the year ending with severe droughts in the months of September to December. The total rainfall for the year was very slightly less

than the 1877 rainfall (71.36 inches), which is the greatest amount on record in the 22 years 1875-1896. The greatest daily fall in 1896 was 17.34 inches on February 20, a phenomenal amount, and the greatest on record in the whole period of 22 years. The tracks of three tropical cyclones which occurred during the year in the South Indian Ocean have been ascertained approximately, but investigation in this important branch of enquiry has been rendered increasingly difficult on account of a considerable falling-off in the number of ships' logs received, the number dropping from 397 in 1884 to 234 in 1896.

Photographs of the Sun were taken daily (weather permitting), and 340 negatives have been forwarded to the Solar Physics Committee. Discrepancies in the table of number of days of sun-spots may probably be attributable to misprints, but on the whole there appears to be a welcome improvement in the printing of this report. We congratulate the new Director on the appearance of his first Report.

PUBLICATIONS.

ANNALES DE L'OBSERVATOIRE ROYALE DE BELGIQUE (Nouvelle série, Tome VII.).—This recent volume from the Uccle Observatory contains amongst other interesting papers a Catalogue of 382 Faint Stars of the Zone B.D. $+2^{\circ}$, observed at Liège by Dr. L. de Ball, between 1886 and 1889. It will be remembered that the scheme of the Astronomische Gesellschaft catalogue only includes stars down to the 9th magnitude, thus excluding more than half of the stars in the Bonn catalogue. The author took upon himself to supplement the work by observing the inter stars, but after three years' work on the zone B.D. $+2^{\circ}$ he came to the conclusion that the recent introduction of the photographic method of mapping stars would greatly surpass his own method in speed, and on this account he decided to bring his work to an end and to publish the results that he had obtained, forming the present catalogue. The instrument used was of $\frac{1}{2}$ -inch aperture and 8 ft. focal length, with a 30-inch circle and two reading microscopes, the whole being non-reversible.

All the observations were made in dark field with wires illuminated, and by the eye-and-ear method. Dr. de Ball considers however, that the galvanic method is preferable, especially as, since the eye-and-ear intervals for all the stars in the zone are practically the same, he finds the observations over the succeeding wires to be biased by the result over the first wire. Three wires in general were used.

The instrument was provided with an unsatisfactory slow-motion screw and the circle was very unevenly divided; the author also enumerates several other minor disadvantages under which it laboured.

The circle has since been redivided, thus preventing a complete determination of the division errors applicable to the present series of observations.

It will be seen that the author has spent a large amount of time under most laborious observing conditions, and the observations seem to be distinctly better than might reasonably be expected.

The author gives a comparison for 26 of his stars which were also observed at Albany, with a discussion as to the probable cause of a noticeable systematic discordance, which he is inclined to attribute, among other causes, to (1) personality depending upon magnitude, (2) the use of a non-reversible instrument.

We have dealt with this section only of the volume owing to considerations of space. It also contains among other matters a method for the solution of Wronski's problem, and a method for the determination of stellar parallax, which we hope to refer to on another occasion.

W. W. B.

THE SUN'S PLACE IN NATURE*.—Sir Norman Lockyer's latest book has been severely handled by some critics in the daily press. The chief charge brought against the author is the fact that he has referred somewhat unfairly, and with something of taunt in his manner, to Sir William Huggins and his views. The point at issue between these two titled astronomers is well known. Lockyer in 1887 put forward a hypothesis that all celestial bodies have their very beginning in meteorites, which coalesce to form nebulae, and these in turn pass through successive stages of development to form suns. This hypothesis did not meet with universal approval—in fact eminent spectroscopists did not hesitate to point out reasons why the hypothesis failed. In the year 1891, when the 'Meteoritic Hypothesis' was fully published, Huggins was President of the British Association, and in his Presidential Address, which was mainly on celestial physics, he made no reference to the recent work. This attitude of silence of Dr. Huggins was evidently annoying to, but is not copied by, Sir Norman Lockyer, for in many places in the book he attacks Sir William in no uncertain way.

We do not propose to take a side in the dispute, but merely to here describe briefly the book, which may be done by saying that it is a new edition of the 'Meteoritic Hypothesis,' brought up to date by the addition of observations and investigations made at South Kensington, and by including a chapter on helium and its discovery as a terrestrial element, which has occurred since the date of the earlier work, and also by adding a chapter with the title "How the Hypothesis has fared," in which Sir Norman Lockyer states the objections to his theory made by various spectroscopists, and his reply to these. As to the Sun's place in

* * 'The Sun's Place in Nature,' by Sir Norman Lockyer, K.C.B., F.R.S.
London: Macmillan & Co., 1897. 12s.

Nature, the assignment of which the title indicates to be the purpose of the book, it may be sufficiently explanatory to quote the following passage :—

The idea which one arrives at by a discussion of all the spectroscopic facts is that we begin with a condition in which meteorites in swarms and streams are very far apart, and from the collisions of these a spectrum results which gives us bright flutings and lines, in other words the spectrum of the nebulae; when they become a little more dense, we get the bright-line stars; and as they become denser still, we find the stars with a mixture of bright and dark flutings. Then still more condensation and dark lines, and at length the highest temperature of all; after which begins the descent on the other side, till at length we end in cool dark bodies like the Earth and Moon. This seems to be the classification which is necessitated by the consideration of all the facts; and it is, moreover, one which appears to give us possibilities of an explanation of the phenomena of new stars and variable stars, and many other things without going into the region of the unknown and the impossible.

This scheme of classification differs from that of Vogel in that the last-named spectroscopist begins with the assumption that all stars are in the beginning hot, and are now in different stages of cooling. Prof. Pickering's classification differs from Lockyer's in some small details only, but he does not commit himself to any views as to the relative temperature of the stars. In Lockyer's table the Sun, with Arcturus and Capella, are in Group V., which comprises stars on the descending side of the curve of temperature.

The book, as giving an account of several years' work at the South Kensington Astrophysical Laboratory, and the Director's deductions therefrom, is certainly one to be read by every student of the science, whatever may be his opinion on the question of controversy.

THE WAR OF THE WORLDS*.—"I wants to make your flesh creep," said the "fat boy," and, like the immortal Joe, Mr. H. G. Wells gave us warning before he did it. His 'Time-Machine' book ended with a somewhat gruesome picture, his 'Island of Dr. Moreau' was ghastly, but his latest book outdoes all his previous work in description of disaster to the human race, and is written with all Mr. Wells's vivid imagination based on his scientific knowledge.

We make no apology for writing of this book in these pages, for its motive is in the first place astronomical. On the assumption that Mars is in a higher stage of development than the Earth, the author predicates that its inhabitants have evolved into beings whose bodies have lost some of the lower attributes of humanity, such as digestion and necessity for sleep, but whose brain-power has largely developed. They attack the Earth, making the journey in cylinders discharged shell-like from their planet. The journey has, to our mind, the greatest ring of improbability of anything in

* 'The War of the Worlds,' by H. G. Wells. London: William Heinemann, 1898. 6s.

the book, for all the shells hit the Earth in the neighbourhood of London; but of course some improbability must be conceded in a book of this kind. On reaching the Earth, the occupants of the shells proceed to build up huge mechanical monsters fifty feet high from material they bring with them. In each of these a Martian takes his position, and controls his monster apparently by nerves of wire and muscles formed of a series of electrified discs. The Martians, who have landed near Chertsey, march on London, destroying the houses and people as they go by means of a wonderful "heat-ray" and by a noxious gas they have discovered the secret of making. Our army, called out suddenly to repel these strange invaders, is utterly powerless and is completely destroyed; in fact Londoners are much in the position of wasps who are having their nest destroyed by the usual sulphur process. The nightmare is brought to a happy logical ending. The Martians are not proof against the harmless, necessary microbe, which our living bodies effectually withstand, and Primrose Hill and St. John's Wood are littered with the machinery that has caused so much destruction. It will be seen that the book is, perhaps, more biological than astronomical, but it is grimly real to read, and is very thought-stimulating.

NOTES.

COMET NOTES.—Ast. Journ. 424 contains the following elements of Winnecke's Comet, which have been corrected by the observations made at the Lick Observatory in January:—

$$\begin{array}{rcl}
 T = 1898 \text{ Mar. } 20.392 \text{ G.M.T.} \\
 \omega \dots\dots\dots 173^\circ 21' 10'' \\
 \Omega \dots\dots\dots 100 \quad 51 \quad 46 \\
 i \dots\dots\dots 16 \quad 59 \quad 34 \\
 \log e \dots\dots\dots 9.854161 \\
 \log a \dots\dots\dots 0.510521
 \end{array} \left. \vphantom{\begin{array}{l} \omega \\ \Omega \\ i \end{array}} \right\} 1898.0.$$

Ast. Journ. 425 contains the following ephemeris of the comet for Greenwich midnight, computed from the above elements:—

R.A.				S. Dec.			
h m s				° ' "			
Mar. 3....	19	58	33	14	30		
7....	20	19	38	14	31		
11....	20	40	31	14	25		
15....	21	1	7	14	12		
Mar. 19....	21	21	20	13	53		
23....	21	41	5	13	27		
27....	22	0	19	12	56		
31....	22	18	57	12	21		

The comet is badly placed for observation, only rising 2 or 3 hours before the Sun.

Ast. Nach. 3472 contains definitive elements of Comet 1892 II. (Swift) by Dr. L. Steiner. This comet was visible from 1892

March 19 to 1893 Jan. 12. Fourteen normal places have been formed at intervals of about 24 days; the earlier ones rest on a large number of observations, the later ones on very few. The normal places were at first weighted proportionally to the number of observations on which they rested, but it was found that better results were obtained by making the weights more nearly equal.

After applying perturbations by all the planets for which they are sensible, the following hyperbolic elements were deduced:—

		Probable Error.
T = 1892 May 11 ^h 26 ^m 19 ^s	Berlin M.T.	0 ^h 00 ^m 38 ^s
ω	129° 19' 51"	7"
Ω	253 25 51	1
i	89 41 54	2
log q	0.294620	0.000008
e	1.000345	0.000064

Ast. Nach. 3471 contains sweeping ephemerides of Tempel's Comet (1866 I.), which is the comet associated with the November meteors. There is practically no chance of this comet being seen before next autumn.

A. C. D. C.

MINOR PLANET NOTES.—Planet 428, discovered by Villiger on Nov. 18 last, has been named Monachia.

A. C. D. C.

THE CONSTANT OF PRECESSION.—The discussion as to the adoption of a new value of the Precession Constant in the computation of national ephemerides, which shall be accepted as final for some years, is still under discussion. Prof. Porro, of the Turin Observatory, published his views on the subject in 'Nature' for Dec. 9, which were decidedly inimical to the proposed scheme. Prof. Newcomb replied to Prof. Boss and Dr. Chandler in the Ast. Journ. No. 413. More recently in No. 423 of the same publication Prof. Boss has a further article, very ably written and very suggestive. He gives a statement of the geometry of the question, for which we can only refer our readers to the original; and while allowing that Prof. Newcomb has evolved the value from his data with all skill, Prof. Boss is of opinion that these same data, viz. Bradley's observations, should not have been alone used in the investigation. The precision of Bradley's observations is not extreme: their real value arises from their distance in time; but, says Prof. Boss, there are observations made between 1820 and 1850 suitable for a determination of the precession-constant, whose greater number and increased accuracy quite compensate for their lack of age. Beyond this Prof. Boss thinks it injudicious that Prof. Newcomb's value should have been predestined for acceptance before it had been examined by, and received the assent of, astronomers generally. The following paragraphs extracted from his article summarize his views:—

"There is no emergency calling for the immediate adoption of

new values of the precessional motion, because there is every reason why there should be a period of increased activity in this line of research. Investigations in stellar problems will probably characterize the astronomy of the twentieth century, as research upon the solar system has been the most remarkable feature in the astronomy of the century now closing.

"The study of the precessional motion ought to be more effectively connected with the definitive solution of problems concerning solar motion, structure of the sidereal system, and general systematic errors in observed star-positions,—all of which ought really to constitute a single general and indivisible problem.

"Material of observation on the brighter stars already exists in rich abundance for a much more comprehensive investigation of the precessional motion than that which is presented in Prof. Newcomb's paper; zone-observations of the fainter stars can also be usefully employed in the study of this problem; and with comparatively little exertion the value of the existing evidence can be very greatly enhanced by further observations now."

Prof. Newcomb replies in No. 426 of the same publication. Agreeing with Prof. Boss he thinks that astronomers of the twentieth century will occupy themselves with stellar problems, and "a most necessary adjunct to such researches as these is a theory and formulæ of the precessional motion which shall be fairly near the truth This preliminary want I have tried to satisfy by constructing formulæ and quantities having the required degree of self-consistency, and as precise as in my judgment the available data would permit."

With regard to the second of Prof. Boss's paragraphs quoted above, Prof. Newcomb points out that he did make his research on these lines as far as the data at his command would allow; and as to the third of the paragraphs he says that he did carefully consider the advisability of using catalogues later than Bradley's as the data for his first epoch, but that after full consideration he was of opinion that these would introduce systematic error, a defect which would not be outweighed by any advantage gained by their use.

As to Prof. Boss's feeling that the new value should not have been adopted before it had been submitted to the astronomical world, Prof. Newcomb replies that the Conference only resolved on the adoption of his value in the National ephemerides which were represented, and did not attempt to legislate for astronomers generally. We certainly think that this pleading is a little weak. The keynote of the resolution evidently was "consistency," so that it is scarcely a logical position for a supporter of the resolution to now turn round and advise people to be inconsistent if they do not like the plan.

STELLAR PARALLAX.—In *Ast. Nach.* No. 3475, Prof. Kapteyn gives the result of some of his "parallax hunting." His

method is very ingenious, and ought to give much more reliable indications than those previously in use. A plate is exposed at each of three maxima, three images being secured at the first, six at the second, and three at the third maximum. Thus there are 12 images of each star on the same plate. As a fact, three plates were used each with a different exposure. Freeing the measures from constant errors, there remain a series of residuals for each star representing the parallax. The plate covers 2 square degrees and contains 250 stars. It is obvious that the results do not pretend to great accuracy, but as a means of finding out stars which may be systematically observed for parallax, and those which may be left alone, it has some merit. Of the 250 stars on the plate there are six showing a parallax of $0''.1$.

Star's name.	Mag.	Parallax.	Star's name.	Mag.	Parallax.
B.D. 3972....	8.6	$0''.11$	B.D. 4003....	9.2	$0''.10$
B.D. 3883....	7.1	$.18$	B.D. 4020....	9.3	$.10$
B.D. 3900....	8.5	$.11$	B.D. 2959....	7.0	$.10$

The star B.D. 3883 certainly offers a field for parallax measures.

ONE of the quasi-astronomical events of the past few weeks has been the, shall we say hoaxing, of certain of the daily newspapers, who have thought fit to announce the reputed discovery of what is called the "second Moon of the Earth." The gentleman responsible for this startling intelligence lives in Hamburg, and seems to have collected instances where different persons saw, or have fancied they saw, dark spots on the Sun, possibly in some cases naked-eye sun-spots. It need scarcely be said that the times of these supposed astronomical observations were all given in the vaguest way; but from such uncertain data the Hamburg astronomer (!) has deduced an accurate orbit of a body which he says is a second satellite of the Earth, and was to transit the Sun's disc on Feb. 3 last. We have not heard of any observations, but it will transit the Sun again this year, so there is still another chance. The only thing about all this that causes us to be surprised, for we are used to seeing similar absurd astronomical theories, is that some Editors should have allowed so much space to be wasted on the subject. One paper, after saying on Jan. 26 "we confess to considerable scepticism as to its reality," on Feb. 7 lets the supposed discoverer fill rather more than a column, containing this beautiful paragraph, which gives a specimen of the data on which the discovery (!) is based:—

Mr. Hoffman, Inspector of the Forest at Gotha, in the first days of May 1762, saw the Sun rising, and upon him again a large round black spot about one-fifteenth of the Sun's diameter, moving slowly along from north to south. In his account the Inspector says he was overwhelmed by the view, and he

asked himself the question whether there be heavenly bodies the dark crest of which would not afford them to refract the Sun's rays so as to exclude them from our sight for ever.

The Inspector was easily "overwhelmed." His question reminds us a little of Lewis Carroll.

WOLSHINGHAM OBSERVATORY CIRCULARS.—Three of these circulars have recently been received from the Rev. T. E. Espin. The last of the three is rather startling. We have not heard of any further observations of the object described therein. The circulars are as follows:—

No. 44, 1898 Jan. 12. The star *Ra.-Birm.* 649, *R.A.* $20^h 3^m 17^s$, Dec. $+41^\circ 12'$ (1900), is variable 8.9–10.2, and *Ra.* 911, *R.A.* $20^h 29^m 55^s$, Dec. $+54^\circ 37'$ (1900), is also variable 9–14.

No. 45, 1898 Feb. 14. An 8th magnitude red star not in the Bonn Durchmusterung was found last night, *R.A.* $7^h 12^m 16^s$, Dec. $+32^\circ 19'$ (1855).

No. 46, 1898 Feb. 16. A remarkable object hitherto unrecorded was discovered on Jan. 16, and seen on three other nights. It is elliptical, 1° long, with its major axis at position-angle 336° , and rather resembles some obscuring medium than a nebula, and is, I believe, unique. Its place is *R.A.* $4^h 26^m 0^s$, Dec. $+50^\circ 44'$ (1855).

THERE is an interesting little note by Prof. Asaph Hall in *Ast. Journ.* No. 426, on the velocities in miles per second with which certain celestial bodies move. There is a binary star μ Scorpii of which the orbital velocity, according to Prof. Pickering, is 286 miles per second. The components of another binary, Cord. G. C. 10534, have an orbital velocity of 379 miles. After these the velocities of Mercury, the Earth, and Neptune, respectively 29.6, 18.4, and 3.4, look very small. He computes the velocities of the great comets of 1843, 1880, 1882, as 351, 338, and 295 miles. The velocity of the star with proper motion of $8''\cdot7$ discovered recently by Prof. Kapteyn, on the assumption that its parallax is $0''\cdot1$, is about 180 miles per second; but this takes no account of its velocity in the line of sight.

THE first award of the Bruce Gold Medal of the Astronomical Society of the Pacific* has been made to Prof. Simon Newcomb, for his distinguished services to astronomy.

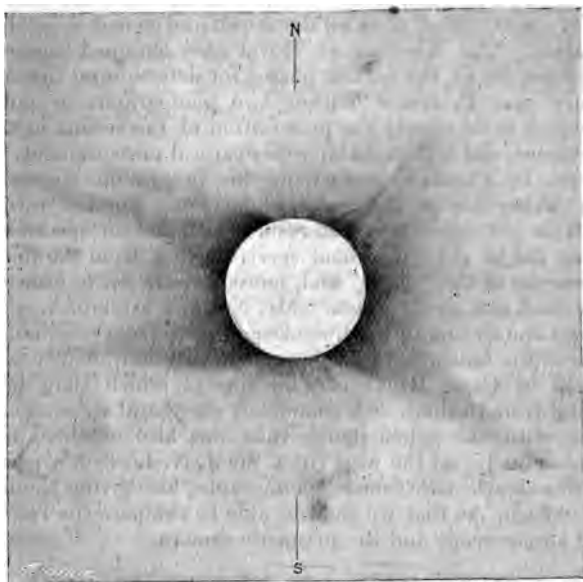
MR. CHARLES GODFREY, of Trinity College, has been elected to the Isaac Newton Studentship of the University of Cambridge.

FROM AN OXFORD NOTE-BOOK.

SUNDAY morning, February 13, in the steamship 'Caledonia' at Suez, and likely to stay there. We were hauled out of our berths

* See 'Observatory,' May 1897, p. 217.

at seven o'clock this morning to be inspected; for we had come from Bombay, where the plague is, and if there had been any plague on board they would not have allowed us to enter the



The Corona as seen at Sahdol. (From photographs.)

Canal. A few passengers who wish to visit Egypt or Palestine left us in a sort of lighter for the quarantine station, where they are to stay two days at least; and then we hoped to move onwards. But we counted without the captain of some little steamer, who, when nearly out of the canal at this end, has managed to jam his boat right across, so that the way is completely blocked. We can see the obstructing steamer, and a *Messagerie* boat which was just caught, quite plainly; and the situation has remained apparently unchanged for some hours. Some of the passengers are beginning to grumble; others to make bets as to the length of our stay. I think I had better write some notes. The chief difficulty is that there is so much to say—a successful eclipse expedition to such a country as India provides one with an embarrassing wealth of material from which to choose. However, there seems to be plenty of time.

In the first place let me announce, with such detail as I have knowledge of, that the weather on January 22 was perfectly fine

all along the central line, and the observations were everywhere successful. Of the expeditions sent out by the Joint Permanent Eclipse Committee, the Astronomer Royal and Professor Turner were farthest east—at Sahdol in the native state of Rewah; and they were well satisfied with their photographs of the corona on different scales, which were all developed and copied before leaving the station. The Astronomer Royal also obtained successfully his photographs of the partial phases for determining the Moon's position; and Professor Turner two photographs in polarized light, which show clearly the polarization of the corona in at least one streamer, and will probably repay careful measurement. Further west, Dr. Copeland carried out his programme successfully, and is taking his plates home to develop. Further west still, Capt. Hills got some very fine results with his slit spectroscopes. Not only did he get the coronal spectrum to 4' from the limb, but the spectrum of the "flash" and, moreover, *the whole history of it both at 2nd and 3rd contacts*. Mr. Newall's attempt to get the motion of the corona in the line of sight at 8' from the limb failed because of the faintness of the spectrum—a failure which is quite explained by Capt. Hills's coronal spectra, which show nothing beyond 4' from the limb. A completely successful series of coronal pictures with the other double-tube was also obtained at this station. Finally, on the west coast Sir J. N. Lockyer's party got two series of prismatic camera photographs, also giving the history of the "flash," so that we shall be able to compare the records of the slit spectroscope and the prismatic camera.

OTHER parties have been equally fortunate. Mr. Michie Smith was at Sahdol, and got some beautiful pictures with a forty-foot camera and polar heliostat. Mr. Burckhalter (who left this boat this morning for Palestine *via* the quarantine station) tells me that though not so completely successful as he had hoped, he has still got sufficient to prove the advantages of his method of graduated exposure. His shortcoming was in not giving small enough exposure to the inner corona, which was brighter than he expected. He tells me that Professor Campbell, from the Lick Observatory, was well satisfied with the results he had got with the apparatus used previously in 1889 by Prof. Schaeberle, and taken out by him to Japan in vain in 1896, and further that the Japanese party have shared in the general success. Mr. Thwaites and Mr. Evershed, of the B. A. A. party, are on this boat, and I have had the pleasure of seeing some beautiful negatives taken by them with a 4-inch Cooke-triplet lens, and with a prismatic camera respectively. Of others I have only heard vaguely, but as yet there is not any hint of failure; and, moreover, Mr. Burckhalter killed a cobra with "rocks."

BEYOND these few facts I know little of any station save our own at Sahdol. This was in dense jungle, which had to be cleared

for our camp. There had once been a great city there according to tradition, and evidence of its existence remained in the shape of several large tanks of obviously artificial origin, and in beautifully carved stones which turned up in all sorts of odd places. But the jungle had been in possession of the ruins for centuries until it was cleared for our camp. Major Burrard, R.E., deputed by the Surveyor-General of India to look after us, had set up a magnificent camp, built brick piers for our instruments, and prepared everything in the most satisfactory way. We shall be rather spoiled for future expeditions.

WE found a fortnight none too long a time for preparation before the eclipse. The conditions for work were thoroughly pleasant, the chief drawback being the severe cold at night. The temperature was near or below freezing all night, and rose rapidly after sunrise to about 80° , at which it remained till near sunset. The nights in tents were thus cold; we generally had dinner in greatcoats; but there was nothing to try us severely. Work kept us busy from early morning till about 4 o'clock, when we sometimes went for a walk with guns to try for ducks or peacocks. There was an elephant put at our disposal by the local Rajah, but we did not care much for elephant-riding after the first day: it is too jolty. Once or twice we went trolleying down the railway, the motive-power being supplied by coolies running on the rails as on a tight-rope and pushing the trolley before them.

TWICE we had arranged for us a big drive of game with fair prospects of at least seeing a tiger; but both times we were disappointed. On the first occasion a tiger did appear, but he favoured other members of the party, and we had not even a glimpse of him. This occasion, however, was made memorable by the exploit of the Junior Member of the Expedition, who to his great delight had been allowed to occupy a "machān" (rough platform in a tree) and was armed with a special weapon of his own which worked with liquid carbonic acid instead of gunpowder. To him appeared a wild boar, at which he promptly fired two shots, and with such telling effect that the animal looked at him reproachfully though it did not stop; but there is no doubt it was hit, and the Junior Member thus took precedence over others of us who hit nothing.

WE had little or no trouble with our instruments. There was no breakage, and the "coclostats" (as they were carefully spelt in the 'Pioneer') worked well throughout. We were a little afraid of the heated air which rose from the ground spoiling the definition; but on laying down straw and keeping it well watered during the day we found that a great improvement was effected, and photographs of the Sun taken by the Astronomer Royal with

his drop-shutter showed good definition. The air was wonderfully clear. The day after the eclipse not only was the thin crescent of the new Moon seen to set to the ends of the horns, but after that the setting of the earth-light could be followed right to the end. This clearness of the atmosphere is doubtless responsible for the fact that there was no "shadow" at totality—a great disappointment to the sightseers. There was not much chromosphere either—no huge prominence such as has been seen occasionally; and most of those who went merely to see the eclipse, and had been told that the chief features were the shadow and the coloured flames, were a good deal disappointed altogether. This is a great pity, for it was a magnificent corona.

MR. MICHIE SMITH had some troubles with his long camera, but he gallantly attacked and overcame them all. There was no rock for him to lean his 40-foot tube against, so he had to build a mountain out of Earth by coolie labour. (The wages of a coolie are three-halfpence per day.) When it was built and the heliostat hoisted on top, the mountain began to subside, and persisted in subsiding, in spite of all remonstrances, until the last. Ten minutes before totality Mr. Michie Smith called for a crowbar and hoisted his heliostat two inches! Then the wind was troublesome, and his clock was not arranged for the latitude of Sahdol and would not go; and during totality he had to stand on the top of "Mount Sahdol" and help it on by hand when necessary. But these difficulties only made his triumph more complete. He got some beautiful big pictures, and has entrusted me with one of them to take to Mr. Wesley, and I wish I had it safely delivered.

THE day of the eclipse was quite perfect. There had been a cloud or two on the Wednesday and Thursday which had made us a wee bit anxious; but for the first time in my experience I got up on an eclipse morning to see a cloudless sky. "Happy is the eclipse day that has no history." All went like clockwork, thanks to constant rehearsals and to the complete police arrangements made by our Survey Officers, who drew a cordon round the camp at 5 A.M. and let no one pass till 4 P.M. At the latter hour the camp changed in a few minutes from a desert to a well-attended and well-dressed *fête*. All sorts of eminent visitors who had been in the neighbourhood came on their elephants to congratulate us on our success, and we had to put off developing till the morrow; for which we were not altogether sorry. A total eclipse is not without its effects on one's nerves.

TUESDAY morning, February 15.—We did get into the Canal at last, but we did not get through it without being "tied up" (to let another boat pass). We were told that they never "tied up" ships suspected of plague for fear the microbes should crawl down

the tie-ropes to the shore. However, they caught us in a place where we could be tied to posts some distance from the shore, and where we had a fine view of the *Messagerie* boat bustling through the bitter lakes, well ahead of us. But even the canal has an end, and we got to Port Said early yesterday morning and proceeded to coal. The boat was accordingly very dirty until we got to sea, and then the weather was dirty; and though she is a fine sea-boat and we had not much to complain of, I found whist more attractive than writing notes. We had a pleasant moment passing the *Messagerie* boat, which was pitching rather badly; but none of us were very enterprising yesterday.

DR. COPELAND came on board at Port Said, having visited Egypt since the eclipse. He had the bad luck to find the spindle of his heliostat (an inch thick!) broken on arrival at Nagpur, and the good luck to get it repaired; the bad luck to find that dust made developing a risky matter, and the prudence to take his plates home undeveloped; and on the whole he is well satisfied. His chief instrument was a 40-foot lens with fixed mirror and moving plate. The comparison of these 40-foot pictures, all obtained in different ways, should be very interesting. We have the Astronomer Royal's lens and enlarger, and coelostat; Dr. Copeland's simple lens, fixed mirror, and moving plate; Prof. Campbell's simple lens, no mirror, but moving plate; Mr. Michie Smith's simple lens, polar heliostat; Prof. Hirayama's simple lens, modified heliostat.

HE gave a graphic account of his experiences in quarantine, which he had to undergo before entering Egypt from a Bombay boat. It appears that the caterer for the quarantine station is the nephew of the Medical Officer. The latter controls the stay of the passengers in quarantine, and the former charges them high prices for poor food and lodging in the meantime. There are obvious advantages in this arrangement—to the Medical Officer and his nephew. Dr. Copeland also met a man in Egypt who did not ask him for bakshish: which reminds me to remark on the curious system of recompense for services rendered prevailing in India. Bakshish is, of course, appreciated there also; but almost equally valuable is the "chit" or testimonial. We were quite touched by the gratitude of our native helpers when they were handed each a piece of paper saying, "I have much pleasure in commending John Smith," or words to that effect.

AFTER the eclipse we had a day or two developing and copying photographs. For the first few plates this is suitably exciting; but there is an inevitable anti-climax about the tail. It is worthy of record, however, that we were not in the least anxious to get away from our camp; indeed we stayed two days longer than we originally intended. Set down part of this as due to mistaken

estimate of time required for finishing the work : there remains a portion due to the pleasantness of our camp-life in the jungle, under the auspices of Major Burrard and Lieut. Crosthwait; and one of the days was a good deal taken up by the search for a tiger with Capt. Pinhey*, which was very enjoyable in spite of our drawing blank. All good times, however, come to an end at last; and late one night we embarked in the saloon-carriage which the East Indian Railway most kindly sent to us, and started on a short sight-seeing tour.

BUT can I say anything adequate of what we saw? Of Benares, where the whole population and a good many visitors religiously bathe every day? Of Delhi with its associations, and Agra with its Taj? We were told that on the eclipse day, if we had not been busy on the Central Line it would have been worth our going to Benares merely to see the bathing. There were 4 lakhs (400,000) of pilgrims come to bathe: for the Ganges at Benares is a very sacred spot, and an eclipse is a very sacred time, and all these were anxious to secure divine favour by being immersed in the proper spot at the proper moment. Had it not been for strict police regulations there would have been a good many lives lost; but by dint of passing in 20 at a time to the sacred enclosure, and making them whisk through the water and up the other side like lightning, the whole lot were got through, and everyone had his, or her, or its dip during the eclipse: and there was a meagre list of accidents amounting to one poor old woman. At the same time, though this is satisfactory to the British tyrant, it must be remembered that many of those concerned would have preferred to die under such holy conditions. Are we justified in interfering?

WE reached Bombay to find the plague rather worse. The Astronomer Royal went on to Madras to inspect the new Observatory which Mr. Michie Smith is preparing at Kodaikanal; and to discuss the situation generally. Col. Rivers was to have come in this boat, but he has gone shooting for another week, and so I started on my way back unaccompanied.

THESE rough notes will, I fear, give a very poor notion of a most enjoyable and successful eclipse expedition; but they are all I can offer at present; perhaps something more complete may get written later. But I am struggling with the report for the Eclipse Committee, and so cannot spare more time for lighter matters.

* Twenty years ago, when Capt. Pinhey and I were at school together, and he was a skilful "back" at Rugby football, some exploit of his was credited in the 'Field' to one Pinkey; and by that name he was called for some time. The proof of this note reaches me to-day with the same spelling (in spite of my care in printing the name in the margin to guide the compositor). It makes one feel quite young again.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

APRIL, 1898.

No. 265.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, March 11, 1898.

Sir R. S. BALL, LL.D., F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. TURNER, M.A., B.Sc., F.R.S., and
F. W. DYSON, M.A.

THE Minutes of the previous Ordinary Meeting were read and confirmed.

Mr. Dyson announced that 107 presents of periodicals and papers had been received since the date of the January Meeting. Thanks were given to the donors of these.

The President. There is a large number of papers on the list for this evening, but there are several Fellows present who have recently returned from India, and have communications to make relating to the recent eclipse. The Meeting will probably consider these of more immediate interest than the papers, and it therefore seems advisable (particularly as Capt. Hills, from whom we hope to hear something, has to leave early) that we should take these accounts of eclipse expeditions first. We are promised communications, illustrated as far as possible, from Capt. Hills, the Astronomer Royal, Mr. Fowler, Mr. Evershed, Mr. Thwaites, Mr. Maunder, and Prof. Turner, and I will call upon them in this order.

Capt. Hills. I show first some photographs of the corona taken with the double-tube camera in conjunction with the coelostat. I think you will agree that these are excellent. The spectroscopic work I attempted was:—(1) the recording of the *flash* or bright-line spectrum of the Sun's limb, both at the beginning and end of totality; (2) the photographing of the coronal spectrum, giving only one exposure of as long a duration as possible. The instruments used were those taken to Japan in 1896—a two flint-prism spectroscope and a four quartz-prism spectroscope. Both these lines of research were completely successful. The coronal spectra

show that the intensity of the light of the corona diminished very rapidly on receding from the limb. No continuous spectrum extends more than about 4' from the limb. Several bright coronal lines are plainly seen, notably a very strong one at about $\lambda 4232$, which has been observed before. The green line at 1474 K is, of course, strongly visible.

The "flash" spectra are very interesting. There is a series both at second and third contacts, which show the transition of the spectrum of the limb from the solar spectrum through the flash to the prominence, and *vice versa*. The photographs taken just about the exact times of contact show an enormous number of bright lines. For instance, in the one taken at the beginning of totality, I have counted about 200 in the region between $H\gamma$ and $H\delta$. I have, of course, only had time to examine these plates in a very cursory manner, but I may mention two or three points which seem to be important. These are:—First. The bright-line spectrum at the base of the chromosphere cannot be described as a reversal of the Fraunhofer spectrum. The lines have different relative intensities: strong Fraunhofer lines are absent in the flash, and bright lines are present in the latter which are absent, or relatively very faint, in the solar spectrum. This completely confirms the conclusions arrived at by Sir J. N. Lockyer on the basis of the 1893 and 1896 prismatic-camera spectra.

Secondly. All the lines photographed by Mr. Shackleton in 1896 were photographed at this eclipse.

Thirdly. The results show that there is ample light for photographing the bright-line spectrum with a slit spectroscope which has a narrow slit, and that there is therefore no necessity to use for this purpose an instrument of such inferior optical resolving-power as the prismatic camera.

The President. I think we have all been very much interested in what we have heard. It would be convenient to postpone discussion on this until we have heard others; but as Capt. Hills has to leave, if there be any question that anyone wishes to ask him, it is necessary to do so now.

As no questions were asked, the President called on the Astronomer Royal.

The Astronomer Royal. I feel, Sir, that the chief honours of this eclipse have fallen to Capt. Hills, who has shown us such very interesting photographs and announced such very important results. With regard to the copies of my photographs which I have to show, I must apologize to the Society, because I only returned to England on Tuesday night, and the negatives which I was bringing back with me have not yet arrived in this country, as they have come round in the ship. I just brought over with me two positives, taken rather hurriedly at our station, showing the extreme results. One was a very short exposure, and the other was the longest. From these I tried to get some lantern-slides which I might show; but I very much doubt whether they will show well on the screen, so I

hope the Fellows will excuse me if they are not able to see anything definite. Prof. Turner and I went to a station in Central India, Sahdol, in the Native State of Rewah, where we took photographs of the corona on different scales, my photographs being taken with a telescope which was designed to show the corona on a large scale. I had the 9-inch photographic object-glass of 8 feet 6 inches focal length, presented by Sir Henry Thompson, and the image was enlarged so that the diameter of the Sun or Moon was 4 inches. It was a matter of very great interest at this eclipse that, besides the telescope which I employed, there were used three or four telescopes giving the corona on approximately the same scale. Mr. Michie Smith had a telescope of about 40-feet focal length at our station, but without any enlargement, so that his corona picture was obtained on nearly the same scale directly as mine was by intermediate enlargement at the lens. Then Dr. Copeland had a somewhat similar lens at some distance from our station, near Nagpur, but not very far off, and Mr. Campbell, from the Lick Observatory, obtained very successful photographs near Jeur on the same scale, and I believe the Japanese astronomers near Jeur also obtained photographs on the same scale. I think, whatever the results may be, the comparison of these photographs obtained with different instruments all on the same scale cannot fail to be of advantage in perfecting our means of photographing the solar corona. The enlargement in the case of my photographs was made with a concave lens of the telephoto form, applied within the focus so as to enlarge the image from 1 inch to 4 inches. I should also mention that, independently of the photographs of the corona, I was anxious to obtain photographs of the partial phase, with a view to determining the position of the Moon relatively to the Sun, in order to determine the error of the Moon's tables at the time of conjunction with the Sun. That is a matter of great interest to those concerned with lunar tables; and there was this great advantage in the eclipse in India, that we had facilities for fixing the exact longitude and latitude of our station—the longitude being a most important factor—thanks to the very accurate work done by the Survey Department of India. I wish to take this opportunity of expressing our deep gratitude and thanks to the Government of India, and particularly to the Survey Department, for all the assistance they rendered us on this occasion. Everything was done that could possibly be done by the Government generally, and more particularly by the Survey Department, to make the arrangements for our camp, to fix our longitude and latitude, and to give us accurate local time, so that we were relieved to a very great extent of various responsibilities which would have weighed too heavily on us if we had tried to carry them out for ourselves. The transit observations were under the charge of Major Burrard, R.E., and Lieut. Crosthwait, R.E., and they did everything required to give us accurate time. I will now try if I can

show you anything on the screen. I took my photographs on plates 12×10 in., and these have been copied on 10×10 in. lantern-plates, which are not well adapted to show, as they do not take in enough of the Sun at a time. I hope at the next meeting I shall be able to show more presentable copies. I took a series of photographs, seven in all, with exposures ranging from 20 seconds, the longest on a rapid plate, to $\frac{2}{3}$ of a second on a slow plate as the shortest, the object in this case being to get the inner detail of the corona.

I am showing these photographs as the two extremes, but I wish the Fellows to understand that there is a whole series between, and it is only by studying the whole series of original negatives that we can get all that is to be obtained from the photographs.

Mr. Alfred Fowler. It will not be possible for me to give anything like a comprehensive account of the work of Sir Norman Lockyer's expedition to Viziadrug, of which I was a member. The complete story, when it comes to be told, will be a very long one, for, as you doubtless know, the party from England was augmented by Prof. Pedler, from Calcutta, and Mr. Eliot, the Indian Government Meteorologist, and in addition by a large number of officers and men of H.M.S. 'Melpomene.' A very extensive programme was therefore arranged, and as a result of the kind and able assistance received from everyone with whom we came in contact, all was in readiness several days before the eclipse took place. The weather throughout, including the day of eclipse, was everything that could be desired, and we were rewarded by a very fine view of the phenomena, and a very complete series of observations and photographs were obtained. I must, however, confine myself to one or two portions of the work.

Although corona-photography did not take a very important place in Sir Norman Lockyer's programme, an efficient instrument was taken out, and in the hands of Staff-Eng. Kerr, R.N., it yielded some admirable pictures of the corona.

The main part of the work at Viziadrug, however, was spectroscopic, and the equipment in this direction was a very strong one. A nine-inch prismatic camera with a prism of 45° was in Dr. Lockyer's charge, a 6-inch prismatic camera with two prisms of 45° was in my care, a large integrating photographic spectro-scope was presided over by Lieut. Quayle, R.N., while a grating spectroscope at the end of a 6-inch equatorial was employed by Prof. Pedler.

One part of the work of the prismatic cameras was to photograph the spectrum of the corona during that part of the eclipse when the chromosphere was obscured by the Moon. For this purpose a variety of exposures ranging up to 50 seconds was made, and several rings due to the corona were photographed. The brightest of these rings is that produced by 1474 K, which shows evidence of a structure similar to that of the inner corona.

A special effort was made to photograph the spectrum of the chromosphere at various levels, and especially in the region of the thin stratum which produces the "flash" of bright lines near the points of second and third contacts. There seems to have been a good deal of misconception as to the problem which this stratum brings before us. Young's momentary glimpse of the phenomenon in 1870 did not enable him to determine the relation of the bright lines to the dark ones of ordinary sunlight, but the work with the prismatic cameras in 1893, and still better Mr. Shackleton's *Novaya Zemlya* photograph, showed that the two spectra were far from similar. There was then no justification for supposing that the absorption which produces the Fraunhofer lines takes place in Young's stratum until the differences could be explained. Nevertheless it seems to have since been supposed by some only necessary to again prove the existence of this thin stratum to demonstrate that it is really and truly the reversing layer. Further light was therefore sought upon this point during the recent eclipse, and for various reasons the prismatic cameras seemed to promise most information.

To make sure of securing the flash spectrum Sir Norman devised a method by which ten exposures could be made near the beginning of totality at intervals of about a second. The first of these exposures was to be made as nearly as possible five seconds before the commencement of totality, the idea being that the first five photographs would show the order of appearance of the bright lines, while succeeding ones would show the introduction of the flash spectrum and the gradual disappearance of the bright lines as the lower reaches of the chromosphere were shut off by the advancing Moon. The determination of 5 seconds before second contact was therefore of great importance, and in order to become independent of chronometers it was ascertained by observing when the visible remaining crescent subtended an angle of 45° , it having been calculated that this would occur 5 seconds before totality. This plan worked admirably, and as a result the ten exposures were very successfully made with both prismatic cameras, and a similar series was taken about the end of totality. The high dispersion employed with the 6-inch prismatic camera has given a tremendous amount of spectroscopic detail, and the photographs make it clearer than ever that the spectrum of the thin stratum which produces the flash is vastly different from the Fraunhofer spectrum. Whether there is any connection between the two remains to be determined.

I think I have said enough to indicate that the Viziadruk expedition has met with a very gratifying success, and to make it clear that the real work—the reduction of the photographs—is only just beginning.

In conclusion I must take objection to Capt. Hills's statement that the slit spectroscope is the best instrument to employ in the investigation of the flash spectrum. There is only one point in

which this instrument has possibly an advantage over the prismatic camera, and that is in producing lines which perhaps admit of slightly more accurate determinations of wave-length. On the other hand, the prismatic camera not only gives us the positions of the various lines, but enables us to ascertain, by the lengths of the arcs photographed, the height to which the vapours producing them extend above the photosphere, and to investigate the spectra of successive layers, both of which are of the utmost importance for solar theory.

Mr. Evershed. The eclipse work which I undertook in India this year was entirely spectroscopic, and covered practically the same ground as that which I attempted in Norway in 1896. It consisted in obtaining photographs of the spectra of the chromosphere, prominences, and corona.

For this purpose I constructed three photographic instruments: a prismatic camera of $2\frac{1}{4}$ inches aperture and 36 inches focus, fitted with two 60° prisms; a slit spectrograph containing two quartz prisms; and a large slitless spectrograph attached to a 6-inch telescope, the latter being mounted on a roughly-made equatorial stand. In addition to these, I had available a 4-inch polar heliostat, kindly lent by Mr. Maw, and a $3\frac{1}{4}$ -inch equatorial telescope with solar spectroscope attached. The heliostat was used to supply light to the prismatic camera and the slit spectrograph, while with the tele-spectroscope I observed the reversing-layer visually to determine the right moment when to expose the prismatic camera and large slitless spectrograph in order to photograph the flash spectrum.

I obtained thirteen photographs in all: one only with the slit spectrograph, which was exposed during the whole time of totality; two with the slitless spectrograph, one at the beginning, one at the end of totality; and a series of ten with the prismatic camera, beginning about 20 seconds before 2nd contact, and ending about the same interval of the 3rd contact.

The single photograph obtained with the slit spectrograph shows no details of any kind on the very faint spectrum of the corona. The large slitless spectrograph yielded two fairly good negatives, but by far the most interesting results were obtained with the prismatic camera.

The photographs taken with this about 20 and 12 seconds before totality show the ordinary Fraunhofer spectrum very finely, but the lines are much less dark than in the ordinary solar spectrum; the F line in particular seems to be almost obliterated by the bright chromosphere radiation. H and K and all the lines of the hydrogen series are represented by bright arcs extending on each side of the continuous spectrum, and numerous other short bright arcs can be made out in the ultra-violet region.

Before making the exposure for the next plate of the series, I removed the slit of the visual spectroscope and watched the narrowing cusp spectrum in the region near "b" without any

slit, beginning to observe not more than 10 seconds before totality. At first I could see the Fraunhofer dark-line spectrum very clearly, just as though the circular slit ordinarily used in observing prominences was still in place. The continuous spectrum, however, rapidly decreased in width, but instead of narrowing down to a single thread of light as I had expected, it suddenly began to break up into a number of narrow bands, between which the bright lines flashed out in the most astonishing way, extending in long arcs over 30 degrees or more of the Sun's limb. At this moment I exposed simultaneously the prismatic camera and the slitless spectrograph. In the resulting photograph obtained with the former, only the stronger lines of the flash-spectrum have been impressed in the region under observation, but in the ultra-violet the spectrum is thickly crowded with bright lines.

Plate No. 4 was given an instantaneous exposure a few seconds after totality had begun; it shows simply the ordinary chromosphere spectrum. But there is a curious feature in the prominence spectrum which is well brought out in this photograph. In the extreme ultra-violet most of the prominences give an apparently continuous spectrum. This appears to begin abruptly at about λ 3660 at the point where the hydrogen series ends, and it extends in an unbroken line at the end of the plate at about λ 3390.

Of the remaining photographs of the series, Nos. 7, 8, and 10 are the most interesting. No. 7 was given an exposure of about 30 seconds, ending just before 3rd contact. The corona line and many of the flash-spectrum lines are clearly shown, crossed by narrow streaks of faint continuous spectrum. The distribution of the "1474" light seems to conform in a general way to the structure of the corona, but the line is much stronger on the east limb than on the west, where it is difficult to trace it.

No. 10, which was exposed about 18 seconds after totality was over, is remarkable for the fringe of bright lines bordering the continuous spectrum in the ultra-violet, where apparently every dark line of the Fraunhofer spectrum ends in a short bright line.

Mr. Thwaites. The object I had in view was to photograph, if possible, some of the finer extensions of the corona. The photograph now on the screen was taken with an exposure of $1\frac{1}{2}$ secs., by means of an equatorially mounted telescope, which has a Cooke's $4\frac{1}{4}$ -inch photo-visual object-glass of about 71 inches focal length. The prominences, as you can see, are visible quite round the limb, and the corona is well shown considering the length of exposure. The next photograph that I put on the screen received an exposure of 9 seconds; the streamers are much extended, that on the S.W. region reaching to the corner of the plate; indeed I think that if the plate had been larger, longer extensions would have been secured. This negative shows the complex structure of the coronal streamers, many different rays interlacing and overlapping can be clearly traced; the Polar extensions also are long and well marked. Ilford ordinary plates were used in all cases. I

should like to add that we had a very pleasant stay in India, and our comfort was much added to by Lieut. Morris, R.A., who was deputed by the Resident of Hyderabad to look after our welfare, and all the members of the expedition are much indebted to him. Whatever we wanted he found, and found quickly—in fact, he told me that if I wanted elephants they would be forthcoming at short notice. The instrument I used was very generously lent to me by Mr. Newbegin, who had intended to go to India, but was unfortunately prevented. I am truly indebted to him.

[In the course of his remarks, besides the photographs mentioned above, Mr. Thwaites showed a picture of the corona taken with 30 seconds exposure, which did not show appreciably much more than that with 9 seconds; also photographs of the Moon taken 3 days and 2 days before the eclipse, for the purpose of testing the focus, and several photographs of the observing huts and the instruments of the expedition.]

Mr. Maunder. I should like to add my tribute to that of Mr. Thwaites to the very great kindness, help, and courtesy which we received from Lieut. Morris, the Assistant-Commissioner of the district where we had our encampment, and from the authorities of Berar generally. My own work in the eclipse was to observe the distribution of “coronium” as shown by the coronal line 1474 K in the corona itself. I had for that purpose a binocular, in one eyepiece of which was a direct-vision prism. You can, I think, follow pretty well the appearances presented to me from the photographs which Mr. Evershed and Mr. Fowler have thrown on the screen. As totality approached the solar spectrum began to show the dark Fraunhofer lines as semicircles, which grew narrower and narrower up to the time of complete totality. Then, as you saw very beautifully on Mr. Evershed’s photographs, the continuous spectrum grew narrower and narrower, and at the ends the semicircles began to turn to light. Finally, just before totality, what was left of the continuous spectrum broke up into a number of fine threads, which snapped and totality began. I was disappointed at first not to be able to detect the 1474 K line, and having seen that I could not make out that line, I devoted the early part of the eclipse to examining the shape of the corona itself; but as the eclipse drew to a close I was able to make out the line on the western side. It was very faint. The continuous spectrum of the corona was considerably brighter than I had anticipated, and I was only able to trace the coronal line to a height of 5 or 6 minutes of arc from the Moon’s limb. I traced it through an angle of 140° , and for that distance it seemed to degrade very regularly from the edge of the Moon outwards. I was not able to detect any reproduction of the detail that I saw in the corona with the direct view of the binocular. I saw neither rifts nor streamers on the 1474 K line, but simply that the line seemed to degrade pretty regularly out from the limb.

That observation was made about 16 secs. before totality was over. I think that my wife would wish to say nothing about her photographs on the present occasion, as we have not brought them with us. At the next meeting I hope to show them.

Prof. Turner. I should like first of all to express my admiration of the work done by the amateurs, which has been shown us by Mr. Evershed and Mr. Thwaites. We of the official expeditions had many advantages which they could not share; and I hope we are the better able to appreciate their excellent work done under less favourable conditions. My own work was, firstly, to take photographs such as Capt. Hills has already shown you, with the other double tube; and, secondly, I had a bit of work of my own, to get photographs of the corona in polarized lights capable of measurement, in order to find out *how much* the coronal light is polarized. [The fact that it is polarized has been long established.] The measurements are, of course, still to be made, and the chief part of this investigation is therefore yet to come. I can only indicate the nature of the results generally by means of a slide or two.

The point of the method was to get two images of the corona in differently polarized lights, the light forming one picture being polarized in the direction of separation of the two pictures, that forming the other in the perpendicular direction. Polarized beams separated in this way are given by a plate of Iceland spar (achromatized with glass); and in my apparatus this plate is placed in the position ordinarily occupied by the prism of a slit-spectroscope. The polarized beams behave in the same way as beams of two distinct colours in the ordinary spectroscope; and having only two colours (instead of an infinite number) we can widen the slit until the two images of it just touch and still not have any overlap. My slit was made in card at the last moment, which accounts for its ragged edge. I had originally a better slit, but it took some time to change it for the second picture; and in rehearsal I found I could with difficulty get through the programme in time. By cutting two slits in the same card I shortened the time for changing considerably; but I introduced this slight raggedness.

Now the point of this double picture of the corona (shown on screen) is that there is a long streamer well shown in picture A which is much fainter in picture B; while picture B has extension in the streamers at right angles to the former beyond that of picture A. This shows the polarization of the corona to be radial.

The effect is shown better in some enlargements which we have been working at; and by comparing enlargements with different exposures we see that the discrepancy between the two pictures (and hence the polarization) is not only shown in the outer streamers, but goes right up to the Moon's limb. [The enlargements were shown on the screen; as also some pictures of the

camp and huts at Sahdol, including Mr. Michie Smith's arrangements, and the transit-instrument used by Major Burrard, R.E.]

The President. Does anyone wish to ask any questions with regard to these very interesting communications?

Rev. Father Sidgreaves. With regard to polarization, as a matter of fact there is always a little confusion in the terminology; and when Prof. Turner spoke of the plane of polarization, did he refer to that plane to which vibration is at right angles?

Prof. Turner. I am afraid I cannot answer that question finally, because I deliberately did not measure which plane it was until I got photographs, and the instrument with which I took them is still at sea; though in case of its loss I have some sky photographs for check. But I am assuming for the purposes of explanation that the polarization is radial; but I am obliged to Father Sidgreaves for asking the question, and so bringing out the fact that as yet it is an assumption, made in this instance for purposes of explanation.

Mr. A. Taylor. There has been no mention of the kind of plates used. It would be of interest to know this. May I also ask if intensity-scales were put on the photographs as was done in the eclipses of 1893 and 1896, so that the light of the corona may be estimated in candle-power.

Capt. W. Noble. Will some one who is an authority on the corona kindly tell us whether this is of a maximum or minimum type? There are at present some very large spots on the Sun.

Prof. Turner. For the photographs taken with the double-tubes, Capt. Hills and I both used Ilford Empress and Ilford rapid, and besides these I also exposed two Rocket plates, and two dry-collodion which were not very successful. Intensity-scales were put on all the double-tube photographs and on all the polariscope photographs. I think Mr. Wesley will tell us something later on of the type of the corona.

The Astronomer Royal. I should add to what I have already said that I took with me Ilford ordinary plates, Ilford special rapid, and Rocket plates, which were also very rapid. I also took out some dry-collodion plates, but found from experiments made before the eclipse that these last were for some reason untrustworthy: still, I did expose one dry-collodion plate for 2 secs., but the result is not altogether satisfactory. I used Ilford ordinary plates for the short exposures, and Ilford special rapid and the Rocket plates for the long exposures, developing in each case with hydrokinone (diluted). This I found suitable by trial on a number of plates of the Sun taken before the eclipse, which showed gradations from the centre to the limb, very much of the same character as we get in ordinary practice at Greenwich.

Mr. Knobel. Would it not have been better to have brought home the negatives undeveloped, that they might have been developed under more favourable conditions?

Lord Crawford. I took some 600 negatives last year in countries

ranging through the South of India, the Malay Peninsula, Singapore, and the coast of Borneo. I developed a few on the spot. Of the rest which I brought home for development ninety per cent. were failures.

The Astronomer Royal. I think Lord Crawford has sufficiently answered Mr. Knobel's question. From enquiries I made of photographers in India, I learned that experience showed that it was extremely hazardous to undeveloped plates to bring them through the Red Sea. In a damp hot climate the film is very likely to be injured. It also seemed well to make copies to be left in India in case of loss of the originals.

Mr. Wesley made some remarks on the corona of 1898, illustrating them by means of Mr. Hansky's picture of the series of coronas which was published in the 'Observatory' for February. He thought that the corona of the present year resembled the intermediate type shown in the eclipses of 1886 and 1896 more than any others of the series. The chief point of difference is that in 1898 the rays are a little more compressed towards the equatorial regions.

The following papers were announced and taken as read :—

D. P. Todd. "On a Convenient Method of Adjusting a Polar Axis to the Diurnal Motion."

Royal Observatory, Cape of Good Hope. "Nebulæ Discovered at the Royal Observatory, Cape of Good Hope."

Lewis Swift. "List No. 7 of New Nebulæ."

A. Stanley Williams. "Long enduring Spots on Jupiter."

C. L. Poor. "The Concave Grating for Stellar Photography."

E. M. Antoniadi. "On the Fallacy associated with the Current Rotation Periods of Venus."

J. Tebbutt. "Equatorial Comparisons of Neptune with 114 Tauri."

Rev. T. E. Espin. "A Remarkable Object in Perseus."

W. W. Bryant. "On the 'Two Method' Personal Equation."

Rev. W. Sidgreaves. "The Spectrum of α Ceti, as Photographed at Stonyhurst College Observatory."

W. G. Thackeray. "The Effect of Latitude Variation on the Ecliptic Investigation."

Royal Observatory, Greenwich. "Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1896, deduced from Photographs taken at Greenwich, at Dehra Dûn (India), and in Mauritius."

A. A. Rambaut. "Note on Dr. Gill's paper on the Effect of Chromatic Dispersion of the Atmosphere on the Parallaxes of α Centauri and β Orionis."

A. C. D. Crommelin. "Ephemeris for Physical Observations of the Moon, 1898, April 16 to 1899, Jan. 1."

E. W. Maunder. "Note on the Zodiacal Light."

The following gentlemen were elected Fellows of the Society:—

Eric Doolittle, Flower Observatory, University of Pennsylvania, Philadelphia, Pa., U.S.A.

Rev. Kingsbury Jameson, M.A., Highfield, Hendon.

Alfred Taylor, Messrs. T. Cooke and Sons, Buckingham Works, York.

The following Candidates were proposed for election as Fellows of the Society:—

George Banaster, Mythe Villa, Tewkesbury (proposed by Rev. C. D. P. Davies).

Edward J. Essam, Billingborough, Lincolnshire (proposed by Rev. W. R. Waugh).

Hon. George Stuart Forbes, I.C.S., Revenue Secretary to the Governor of Madras (proposed by C. Michie Smith).

Rev. William Edward Winks, 58 Richmond Road, Cardiff (proposed by Arthur Mee).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE fourth ordinary Meeting of the Eighth Session of the British Astronomical Association was held at Sion College on Wednesday, the 23rd February, *Mr. W. H. Wesley*, Vice-President, in the Chair.

The election of eight new members was confirmed, and the names of nine new candidates for membership were read and suspended.

It was announced that a *Conversazione* would be held on April 19, to welcome back the members of the Eclipse Expedition.

Mr. J. M. Offord read a paper entitled "Experiments in Lunar and Planetary Photography," illustrated by a number of lantern-slides taken by the author. Mr. Offord stated that the result of his experiments so far went to prove that, with a telescope of short focal length and large aperture, the finest photographs could be obtained by using enlarging lenses, confining the field to one portion of the Moon alone, and keeping the camera within a reasonable length, say 15 inches.

The Chairman remarked that the photographs shown by Mr. Offord, especially those of the Moon, were very fine, and he was to be congratulated upon the success he had attained.

The Chairman then mentioned that Mr. Thwaites, who had just arrived from India, and was the first member of the Eclipse Expedition to reach England, was present, and would no doubt give some account of his trip.

Mr. Thwaites said the Eclipse Expedition was greatly indebted to the Indian Government for the assistance they had rendered, and for the way in which they had contributed to their comfort. The air, during the eclipse, was beautifully clear and steady, there being no clouds nor dust-storms. The spectacle itself was truly wonderful and one ever to be remembered. The rays were pearly-white and were long extended. By an eye estimate, he calculated that the south-west ray was about $2\frac{1}{4}$ diameters of the Moon in length. He exposed three plates and was about to make a fourth exposure when the Sun suddenly popped out, totality being a trifle shorter than had been anticipated.

The photographs taken by *Mr. Thwaites* were then thrown upon the screen. He explained that the instrument he used was a Cooke's equatorial refractor with a $4\frac{1}{4}$ -inch photo-visual object-glass of 6-ft. focal length, provided with a driving-clock and electrical illumination, which was kindly lent to him by *Mr. Newbegin*.

Mr. Newbegin said it seemed as if there was a considerable wealth of Polar wisps both North and South. They seemed to have extended much further from the Sun than on previous occasions.

The Chairman said there was no doubt that the polar rays, although very distinct and quite characteristic, did extend a long distance, perhaps rather longer than those rays usually did. The corona was somewhat like that of 1896, but showed, as might be expected, some approach towards the Sun-spot minimum type. Thanks were due to *Mr. Newbegin* for his public spirit in lending his telescope. How good the object-glass was could only be realized by those who, like himself, had examined the original negatives. Of course no lantern-slide could do them justice.

The Rev. T. E. Espin stated that on Jan. 16 last, while sweeping between Perseus and Auriga, he came upon what at first he took to be a cloud. He was quite unable to describe it except that it appeared to obscure the stars. He had seen it again a night or two later and it had been observed at Edinburgh. It was not a nebula, and appeared to be something quite unique.

The Rev. T. E. P. Phillips contributed a paper on "The Doubling of the Canals of Mars," in which he discussed the theory of *M. Antoniadi*, that the doubling was a subjective phenomenon due to slight focussing errors on the part of observers. He had succeeded in reproducing almost all the gemination phenomena as seen and drawn by *Schiaparelli* and others, and he thought this theory was a more reasonable one than the assumption that the appearances were due to such enormous physical changes as it would be otherwise necessary to assume.

Mr. Maw said that since the last meeting he had had an opportunity of trying some experiments, and he found that he could easily produce the appearance of doubling by putting the

instrument slightly out of focus, but it was impossible ever to mistake a doubled line due to defective focussing for two clear well-defined lines.

Mr. Petrie then read a paper by *Mr. A. Stanley Williams* on "The Diurnal Light-Curves of the Dark Spots in Atlas."

The Meeting adjourned at 7 P.M.

ROYAL METEOROLOGICAL SOCIETY.

At the Meeting of this Society held on Wednesday evening, March 16, at the Institution of Civil Engineers, *Mr. F. C. Bayard, LL.M.*, President, in the Chair, a Lecture on "Photographing Meteorological Phenomena" was delivered by *Mr. A. W. Clayden, M.A.*, Principal of the new College at Exeter, who gave details of his experiences as Secretary of a Committee of the British Association. After referring to the extreme value of photographic methods of recording the movements of instruments, the lecturer spoke of the real importance of preserving photographic records of all sorts of unusual meteorological phenomena, and emphasized the necessity of companion photographs showing the same scene under normal conditions. It was suggested that meteorologists throughout the country should cooperate with the Royal Meteorological Society in securing such records. The phenomena of the lightning discharge, as distinguished from those of a single flash, were next described and illustrated by a number of lantern-slides. Some of the puzzles offered by lightning photographs were next alluded to, and the lecturer stated that he had repeatedly found that a single discharge lasted several seconds. *Mr. Clayden* then spoke of the "black" flashes shown in photographs, and described the steps by which, some years ago, he was led to the proof that they were merely a photographic phenomenon, but one which still remains unexplained. Passing on to a consideration of cloud photography the various methods in use were explained, and a large number of lantern-slides were exhibited, in some of which the clouds were shown on a background of blue sky in nearly their natural colours, a result obtained by the employment of suitable developers on a specially prepared plate. The method employed at Exeter by the lecturer for the measurement of cloud altitudes was fully described. This differs from all other methods in using the Sun as a reference-point. *Mr. Clayden* then spoke of the difficulty of getting good pictures of cirrus clouds, and described the methods which depend on the polarization of the blue light of the sky. He expressed a conviction that polarization had nothing to do with their efficiency, which was really due to a general lessening of brightness which enabled the exposure to be properly judged.

Mr. McClean's Photographs of Stellar Spectra.

A PAPER of the first importance in the field of stellar spectroscopy was read before the Royal Society by Mr. Frank McClean on February 3, 1898. It formed a continuation of a paper which he had contributed to the same Society some nine months previously. The earlier paper was accompanied by 160 photographs of stellar spectra, chiefly in the northern hemisphere. These were taken on a scale of 1 inch for the distance F to H by means of an object-glass prism of 12 inches aperture and 20° refracting-angle, used in connection with Mr. McClean's photographic telescope at Tunbridge, and embraced practically all the stars down to magnitude $3\frac{1}{2}$ in five-eighths of the celestial sphere. The remaining portion of the heavens was dealt with by Mr. McClean during the months of May to October 1897 at the Cape Observatory, where he used his own object-glass prism mounted on the astrographic telescope, the use of which was accorded him for the purpose by Dr. Gill. This portion of the Survey yielded 116 spectra, the actual photographs of which have not yet been presented to the Royal Society, but some of the leading results from them are supplied in Mr. McClean's second paper. The two papers, therefore, taken together, represent a complete spectrographic survey of all the brighter stars from pole to pole upon an ample scale.

The discussion of the material which Mr. McClean has thus gathered deals with three principal points. First of all, he has found it necessary to modify Secchi's system of types in the classification which he has adopted. The modification is small but important, as it is confined to dividing Type I. into three divisions, the first of which is further divided into two subdivisions. The three divisions are those of the Orion stars or the helium type, the Sirian stars or the hydrogen type, and the Procyon stars or the hydrogen and iron type. It has, of course, long been felt that Secchi's classification was inadequate for the material at present at our disposal. The pity is that so many and such different methods have been adopted for extending it, so that a real danger lies before us that with so many different schemes of classification we may be landed in utter confusion. It will be seen, however, that Mr. McClean is most conservative in his suggestions, and his modifications are made for very cogent reasons.

Mr. McClean argued in his earlier paper that the first division, the helium stars, are in the earliest stage of development from gaseous nebulae. This point will be very generally conceded, and it is supported by three lines of evidence. First, the correspondence of the dark lines in these stars to the bright lines of gaseous nebulae; next, the fact that the groups of stars connected with the nebulae of Orion and of the Pleiades belong to the helium type; and, thirdly, that these stars and the gaseous nebulae show a similar distribution in the galactic zones.

This last-mentioned fact is one brought out under the second

point with which Mr. McClean has engaged himself, namely, the distribution of the various types of spectra in different galactic regions. For this purpose he has divided the sky into eight equal areas—two round each of the galactic poles, and two on each side of the galactic equator and extending up to 30° from it. The following table summarizes the results of this enquiry:—

	Galactic Regions.			
	Upper Polar.	Upper Equatorial.	Lower Equatorial.	Lower Polar.
<i>Stellar types.</i>				
Division I.	9	29	42	9
„ II.	13	9	5	6
„ III.	16	9	17	6
„ IV.	23	17	25	22
„ V.	4	5	5	5
<i>Nebulæ.</i>				
Planetary	4	10	11	2
Extended	2	8	11	5

The table brings out clearly the manner in which the helium stars favour the galactic equatorial zones, whilst Divisions IV. and V., which correspond to Secchi's types II. and III. (the solar and the α Herculis types), are as nearly as may be equally distributed about the sky. The gaseous nebulæ which are added for comparison obviously share the preference of the helium stars for the equatorial zones. Both these are extremely suggestive relations. The apparent irregularity in the distribution of the Sirian and Procyon stars is no doubt simply an effect of the restriction of the survey to stars of magnitude $3\frac{1}{2}$ or brighter. The richness of the Milky Way in fainter stars of the type has been well known for some years.

The third and most important point dealt with by Mr. McClean is the identification of a number of lines in the spectra of stars of the Orion type with those of oxygen. The general grouping of the lines of the oxygen spectrum is extremely similar to that of these hitherto unexplained lines, but in a large number of cases the individual lines show a slight difference in wave-length as at present determined. The identity, therefore, cannot yet be said to be definitely established, though it is rendered distinctly probable. It is scarcely possible to exaggerate the importance of this identification, since it would bring the most abundant element, as we

know it here on Earth, for the first time into prominence as a factor in celestial spectra. There may well be a special significance, too, in the appearance of these oxygen lines in the younger stellar spectra and in them alone.

Another point of considerable interest is exemplified by the photographs which accompany the second paper, and which are enlarged $8\frac{1}{2}$ times from the original negatives—namely, the existence of the helium lines in the spectrum of γ Argûs, the brightest of the strange Wolf-Rayet stars. Mr. McClean therefore classes these in his Division I. *b*. γ and μ Centauri are also classed under the Division I., as both show the helium lines very distinctly, although their special characteristic is the presence of hydrogen bright lines.

Mr. McClean is greatly to be congratulated on his having brought so important a contribution to stellar spectroscopy to so successful a conclusion, and especially on the thoroughness with which he has carried it out, not only in our northern latitudes, but also where every such research is of especial value—in the southern hemisphere. The worth of such a survey is immensely enhanced when, as in the present case, it is carried on with practically the same instruments over the entire sky. The results accruing from it are already important, and no doubt the 276 photographs obtained will yield much additional information on further discussion.

E. W. MAUNDER.

*Some further Notes on the History of the
'Nautical Almanac' *.*

MR. DUNKIN mentions in his notes that Malachy Hitchins, the "comparer" of the 'Nautical Almanac,' died in the year 1809, and that he was succeeded by Mr. Brown, of Tideswell, in 1811. Dr. Maskelyne died in this latter year, and the responsibility for the preparation of the almanac devolved upon John Pond, who succeeded Maskelyne in the office of Astronomer Royal. In a preface to the almanac of 1820, dated 1817 January, which is signed by Pond, it is stated that when he went to Greenwich he found the almanacs for 1814, 1815, 1816, and for January and February 1817 computed and ready for press. These three completed volumes were therefore issued as Maskelyne's production, with the preface, which, similarly to that of the present day, gave the origin of the data of the computations, signed by him. The almanacs for 1817 and 1818 had no preface, but those for 1819 and following years contained Maskelyne's preface printed under his name. It is noteworthy that Pond did not add his signature

* The interest of Mr. Dunkin's Notes reprinted in the January and March numbers has induced us to collect some information on the same subject which will continue the story to the present time.

to any editions, except to the almanac for 1820, as above mentioned, and to that for 1833, which will be spoken of later; but that he was responsible for the work is shown by the authorization to the printer, a copy for which was printed in each volume, and in which it states that the almanac would be delivered to him by the Astronomer Royal, Nevil Maskelyne or John Pond, as the case might be.

This authorization to the printer was but a small part of the miscellaneous reading forming the introduction to the almanac proper. There was given in full the text of the Act under which the Board of Longitude existed, with description of its duties. To this there was added, in the volume for 1821 and succeeding volumes, the text of the Act which directed the Board to offer rewards for the discovery of a North-West passage between the Atlantic and Pacific Oceans, and for an expedition more or less successful to the North Pole. £20,000 was the prize which any ship would receive for making a voyage from the Atlantic to the Pacific through the Arctic Circle. A ship which reached north latitude 83° would be rewarded with £1000; if it attained 2° farther north, another £1000 would be added. £3000 was the prize for latitude 87° , £4000 for 88° , and £5000 would be the reward for the crew of a ship which managed to get within 1° of the North Pole. Following these Acts were the letters from the Board of Longitude to the printer and publisher* respectively, authorizing them to do their respective functions, and then followed the preface by Dr. Maskelyne, except in some volumes after 1818, when this was put at the end of the book.

Few changes were made in the form of the almanac from its beginning in 1767 to 1832. The volume was divided entirely into monthly sections, and the ephemerides were computed for Greenwich *apparent* time. The Sun's longitude was given in arc to seconds; the right ascension in time to tenths of seconds, the declination to seconds. The Moon's longitude and latitude were given to a like degree of accuracy, her time of meridian transit in hours and minutes, but her right ascension and declination were given only in degrees and minutes until the year 1823, when these quantities were given in seconds, and only for noon and midnight of each day, as were also the longitude and latitude. The semi-diameters of Sun and Moon, and the Equation of Time were given; and besides these the section for each month contained lunar distances for every three hours to seconds of arc, and very much abridged ephemerides of the major planets; of the phenomena of Jupiter's satellites the eclipses only were predicted and the configurations given. Circumstances of solar and lunar eclipses and occasional phenomena were briefly stated. A short catalogue giving the mean places of a few prin-

* The printers were successively Richardson & Clark, William Richardson, Christopher Beckton & Thomas Bensley. The publishers, John Nourse, Peter Elmsley, Payne & Macinlay, and John Murray.

incipal stars is found in some almanacs ; and in that for 1822 Pond added the apparent places for every tenth day of 24 stars, which number was increased to 60 in 1827. Appendices were frequently added on miscellaneous astronomical subjects, and in 1828 and the few succeeding years supplements were issued, which were obviously acknowledgments of the insufficiency of the almanac itself.

The time, however, was at hand when great changes were to be made. In July 1828 Parliament passed an Act* repealing the laws relating to the discovery of a method for determining the longitude at sea, and thus the Board of Longitude was dissolved. The same Act gave authority to the Lord High Admiral to continue the publication of the 'Nautical Almanac,' and the volume for 1832 was issued with "Published by order of the Board of Admiralty" on the titlepage, and this therefore seems to have been a fitting time for the needed alteration in the work. There was evidently some feeling against Pond as Superintendent ; in a well-known pamphlet by the Rev. R. Sheepshanks, the author speaks of a "persecution" of Pond by Sir James South, then President of the Royal Astronomical Society, Mr. Babbage, and Capt. Beaufort ; and Lieut. Stratford, who was at that time one of the Secretaries of the Society, was no doubt one of the cabal. There is reason, too, for thinking that through malicious report, or from other causes, the 'Nautical Almanac' was in disrepute, so that it is not surprising that the Board of Admiralty asked a Committee of the Royal Astronomical Society to make a report relative to the improvement of the 'Nautical Almanac.'

Pond meanwhile had probably been asked to attempt some improvement in the publication, and brought out the almanac for 1833 with several alterations. The Moon's place was given for every third hour to hundredths of a second, and the times of rising and setting at Greenwich of the Sun and Moon were given. The only time during the existence of the ephemeris. Mr. Pond was commended by the Committee for this extension of the lunar ephemeris, which was not only adopted but further extended by them, as they suggested that the Moon's place should be given for every hour. The Report of the Committee, adopted by the Council of the Royal Astronomical Society, 1830, November 19, and ordered by the Commissioners of the Admiralty to be carried into effect, recommended the preparation of the almanac in practically the same form as we have it to-day. As to the future directorship, the Committee naturally had nothing to say ; but at a Meeting of the Board of Visitors of Greenwich Observatory in March 1831, nominally called to discuss the matter of the directorship, but actually to take the office from Pond and to give it to Lieut. Stratford, it was resolved that it was incompatible for the same man to hold the offices of Astronomer Royal and Superintendent of the Almanac. Mr. Sheepshanks, who is our authority for the existence

* The text of this is in the Almanac for 1831.

of this caucus of Stratford's friends, while deprecating it, nevertheless voted in favour of the resolution. He says that although he thought Mr. Pond was not able to execute the two offices, in certain cases (he meant if Airy were the man) the two offices would be not only compatible, but ancillary; which, judging from Sheepshanks's writings, is less a tribute to Airy's genius than a piece of evidence of the unbounded admiration that Sheepshanks had for that gentleman. And so Lieut. Stratford was made Superintendent, and the almanac for 1834 was issued in very much the same form as we have it to-day, from the 'Nautical Almanac' Office, Somerset House, with a preface signed by the Superintendent, and dated 1833, July 19. In the preface we find the names of some of the computers. Mr. W. S. B. Woolhouse, the famous arithmetician, appears to have been chief; then Mr. Farley and Mr. Godward, whose names are familiar as those of computers of much skill. Other gentlemen who helped in the work were Messrs. Russell, Alger, Middlemist, Henry Jenkins, and William Dunkin. We are told by Mr. Edwin Dunkin that his father and Mr. Jenkins were the only members of the original staff who joined the London office. H. P. H.

[To be continued.]

The 'Nautical Almanac' for 1901.

THE 'Nautical Almanac' for 1901 lately published contains some important alterations. In accordance with the recommendations of the Paris Conference, the values of the constant of aberration, precession, nutation, and solar parallax have all been changed—aberration from $20''.445$ to $20''.47$, nutation from $9''.24$ to $9''.21$, solar parallax from $8''.848$ to $8''.80$, and precession from Struve's value of $50.2411 + 0.0002268t$, where t is the interval in years from 1800, to that so lately determined by Prof. Newcomb $50''.2453 + 0.0002225t$, where t is the interval in years from 1850. In view of the fact that the determination of the constant of aberration is very much mixed up with the variation of latitude, and that there are several astronomers engaged on special determinations of this particular constant with a special view to disentangle its value from any influence due to latitude variation, it cannot be said to be a favourable time to make any change in this particular constant, though the value $20''.47$ seems a move in the right direction. The value of the solar parallax is the only change which can be heartily approved of; the alteration of the constant of precession is still the subject of serious debate amongst astronomers. It is an irritating sort of correction, and it does not appear to wear on its brow the stamp of finality. To working astronomers it is just about sufficient to cause trouble; it will upset tables which have been made to facilitate computations; it will prevent comparisons between different catalogues for values of precession and secular

variation, which are so useful to ensure accuracy of computation. Like a mosquito-bite, it is not a very serious matter, but it leaves a nasty sting behind.

In addition to these alterations in the values of the chief astronomical constants, the places of the Sun, Mercury, Venus, Jupiter, and Saturn are now derived from Newcomb's Tables in "Astronomical papers of the American Ephemeris and Nautical Almanac," in place of Leverrier's Tables, and the mean places and proper motions of the stars have been derived from the International Catalogue of Fundamental Stars prepared by Prof. Newcomb in accordance with the decisions of the Paris Conference on Fundamental Stars, and which has not yet been published. The annual variations of the stars depend upon the new value of the precession and consequent changes in the proper motions. The North Polar distances depend upon the Poulkova refractions. As the Greenwich clock-star list for 1898 depends upon the values of the Right Ascensions of the new Ten Year Catalogue for 1890 (not yet published), a direct comparison between the two systems can be easily made. Bringing up the Greenwich results to 1900 by the Struve-Peters value of precession and Auwers' proper motion, and taking (Greenwich - Newcomb, the resulting correction to Newcomb is $-0^{\circ}.056$. By far the largest part of this difference is accounted for by the correction which is shown to be required by the Greenwich observations from discussion of the Sun-observations 1836-1895 (M. N. lvi. 9), say $+0^{\circ}.042$, derived from the formula $+0^{\circ}.015 + 0^{\circ}.132t$, where t is reckoned from 1880 in fractions of a century. The following table shows the comparison between the annual variations of the clock-stars for each hour of Right Ascension, derived from the Struve-Peters values of precession and Auwers' proper motions on the one hand, and Newcomb's values of precession and proper motions on the other, as corrections to the system of Struve-Peters and Auwers or the system adopted at Greenwich:—

Limits of R.A. h h	Correction. s	No. of stars.	Limits of R.A. h h	Correction. s	No. of stars.
0-1	$+0^{\circ}.011$	10	12-13	$+0^{\circ}.011$	10
1-2	$0^{\circ}.011$	7	13-14	$0^{\circ}.007$	7
2-3	$0^{\circ}.013$	10	14-15	$0^{\circ}.010$	8
3-4	$0^{\circ}.012$	10	15-16	$0^{\circ}.008$	10
4-5	$0^{\circ}.007$	8	16-17	$0^{\circ}.008$	8
5-6	$0^{\circ}.010$	9	17-18	$0^{\circ}.010$	8
6-7	$0^{\circ}.008$	11	18-19	$0^{\circ}.011$	8
7-8	$0^{\circ}.006$	8	19-20	$0^{\circ}.014$	12
8-9	$0^{\circ}.009$	7	20-21	$0^{\circ}.014$	9
9-10	$0^{\circ}.008$	8	21-22	$0^{\circ}.011$	9
10-11	$0^{\circ}.015$	8	22-23	$0^{\circ}.012$	11
11-12	$+0^{\circ}.012$	7	23-0	$+0^{\circ}.011$	5

giving a mean correction of $+0^{\circ}.0010$. The periodic difference in the corrections is due to the systematic errors of the Greenwich

1864 Catalogue, from which Auwers derived his proper motions : see Newcomb, 'Astronomical Papers of the American Ephemeris and Nautical Almanac,' viii. part 1.

Correcting the Greenwich observations to the Sun results for 1836-1895, it is easily seen that these Sun results give the following correction to Newcomb's Fundamental Catalogue of $-0^{\circ}.014 + 0^{\circ}.032t$, where t is the number of years from 1900 reckoned as a fraction of a century. As regards the adoption of Poulkova refractions ('Tabulæ Refractionum in usum speculæ Pulcovensis congestæ,' Petropoli, 1870), the value of the coefficient of the refraction adopted therein was $0''.16$ smaller than that adopted by Bessel in his 'Tabulæ Regiomontanæ.' From a discussion of the results of the Greenwich and Cape Catalogues for 1880 by Prof. Turner and Mr. Hollis (Mem. R. A. S. li.), it seems that a diminution of the coefficient of refraction of about $0''.13$ would suit the circumpolar observations at both observatories. Assuming that the refraction varies as $\tan z$ as far as 80° Z.D., the following table shows the correction to Bessel's refractions for (1) Poulkova refractions (barometer 30.0 in., thermometer $50^{\circ}.0$, 'Cape Catalogue,' 1885, Introduction, p. xxxv); (2) a diminution of the coefficient of refraction of (a) $0''.16$, (b) $0''.13$:—

Z.D.	Poul- kova.	$0''.16$ tan z.	$0''.13$ tan z.	Z.D.	Poul- kova.	$0''.16$ tan z.	$0''.13$ tan z.
0	"	"	"	55	$-0^{\circ}.23$	$-0^{\circ}.23$	$-0^{\circ}.19$
10	$-0^{\circ}.02$	$-0^{\circ}.03$	$-0^{\circ}.02$	60	$0^{\circ}.28$	$0^{\circ}.28$	$0^{\circ}.22$
20	$0^{\circ}.06$	$0^{\circ}.06$	$0^{\circ}.05$	65	$0^{\circ}.33$	$0^{\circ}.34$	$0^{\circ}.28$
30	$0^{\circ}.09$	$0^{\circ}.09$	$0^{\circ}.08$	70	$0^{\circ}.41$	$0^{\circ}.44$	$0^{\circ}.36$
40	$0^{\circ}.13$	$0^{\circ}.13$	$0^{\circ}.11$	75	$0^{\circ}.51$	$0^{\circ}.60$	$0^{\circ}.49$
50	$-0^{\circ}.19$	$-0^{\circ}.19$	$-0^{\circ}.15$	80	$-0^{\circ}.61$	$-0^{\circ}.91$	$-0^{\circ}.73$

As to the material upon which the actual star-places depend, it is impossible to make any remarks, for there is no information on the subject. Astronomy has now got to a stage where star-places derived from a fundamental catalogue carried on for a number of years by means of precession and proper motions will give the most consistent results; and if a somewhat feverish anxiety to introduce changes which shall be commensurate with the beginning of a new century has led to the adoption of results which have not yet seen the light of day, yet an external stimulus, however artificial, is generally required to get people together to confer on somewhat abstract matters. It certainly is not a precedent to be imitated.

W. G. T.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Adam Smith and Astronomy.

GENTLEMEN,—

It is not very generally known that the author of the 'Wealth of Nations' composed in his younger days a short history

of astronomy up to the time of Newton, which forms part of 'Essays in Philosophical Subjects,' a work published in 1795, five years after the author's death, and to which is prefixed an account of his life and writings by Dugald Stewart. The editors (Black and Hutton) state that the author left at the end of his Essay some notes and memoranda, by which it appears that they considered the last part of his history of astronomy as imperfect and needing several additions (scarcely remarkable, as there is internal evidence that it had been written much more than thirty years before the author's death), but that they had chosen rather to publish than to suppress it, "chiefly as an additional illustration of those principles in the human mind which Mr. Smith has pointed out to be the universal motives of philosophical researches."

It is well known what care Adam Smith took that those of his writings which he did not desire to have published should be destroyed. His own opinion of the brochure in question therefore may be of interest. It is expressed in a letter to Hume, dated Edinburgh, 16th April, 1773 (whilst preparing for a journey to London), which begins thus:—"As I have left the care of all my literary papers to you, I must tell you that, except those which I carry along with me, there are none worth the publication but a fragment of a great work, which contains a history of the astronomical systems that were successively in fashion down to the time of Des Cartes. Whether that might not be published as a fragment of an intended juvenile work, I leave entirely to your judgment, though I begin to suspect myself that there is more refinement than solidity in some parts of it." Fragmentary it certainly is, and the full title is "The Principles which lead and direct Philosophical Enquiries, illustrated by the History of Astronomy"; it is only in the fourth (though much the longest) section that we come to our science. But still it is, on the whole, a very lucid and painstaking account of the ancient systems of astronomy, which would bear reprinting at the present day, especially if accompanied by a few explanatory notes. In one place he repeats the mistake made in so many books, to which I called attention lately in the 'Observatory,' that the fact that Venus and Mercury showed phases like the Moon was itself a proof of the Copernican theory. Speaking of comets, after stating that Newton unfolded the true nature of their motions according to his principles of universal gravitation, he adds:—"His followers have from his principles ventured even to predict the returns of several of them, particularly of one which is to make its appearance in 1758." This is the passage which proves that the little treatise in question was written before (how long before does not appear) the first predicted return of Halley's Comet, whose name should have been mentioned. In 1758, I may remark, Adam Smith held the post of Professor of Moral Philosophy at Glasgow.

Yours faithfully,

W. T. LYNN.

Definition during an Auroral Display.

GENTLEMEN,—

In page 61 of Webb's 'Celestial Objects for Common Telescopes,' 5th Edition, there is a description given of the fine definition in examining planetary details when viewed through a display of the Aurora Borealis. It has often been a desire on my part to test the definition under such conditions, and on Tuesday, March 15, a very fine display occurred, the auroral streamers radiating from a large corona in the north and tending to converge to a point situated in the south and below the horizon. Turning my 5-inch refractor, with power 156, on Jupiter at 10 o'clock, the planet appeared very clear but rippling a little. The large bay below the "Red Spot" was on the central meridian, and the following shoulder crossed the C.M. at 10^h 16^m. The preceding part of the "Red Spot" was clearly visible, like a faint orange streak bounding the more southerly part. The various tints of the surface were beautifully seen, but the forms of the details difficult to determine, owing to the vibrating image caused by a westerly current of air.

The telescope was turned to θ Hydræ, where the 12th magnitude comes was bright enough to bear red illumination; under ordinary conditions this small star does not stand illumination well, though easily seen when the light is turned off.

The triple star ζ Orionis was also clearly defined, the close 6.5 magnitude companion being very distinct and quite clear from ζ ; usually it is seldom this star is well defined.

From the above it will be noted that during the auroral display the air was extremely clear, but not perfectly steady. The sky was nearly as bright as it is in full moonlight.

I am, Gentlemen,
Yours faithfully,
HENRY MAC EWEN.

Mount Florida, Glasgow,
1898, March 21.

Flamsteed and the 'Atlas of the Heavens.'

GENTLEMEN,—

One does not like to be the one fault-finder respecting so excellent a work as Mr. Peck's 'Observer's Atlas of the Heavens,' nor should I have called attention to the following small error were it not that it is frequently made by those who are not in the habit of consulting old star-catalogues. In the preliminary explanation we read (p. 6):—"Flamsteed, the first Astronomer Royal at Greenwich, used constellation-numbers entirely for the stars which he observed, and his numbers are still employed as far as they go for all stars to which no Greek or Roman letters have been attached." Similarly, Prof. Newcomb says ('Popular Astronomy,' 2nd edition, p. 430):—"Most of the other stars down to the fifth magnitude are designated by a system of numbers assigned by Flamsteed in his Catalogue." But as a matter of fact, no numbers

are affixed to the stars in the 'Catalogus Britannicus.' The Bayer letters are given for stars which have such; the rest are left without name or number, though the positions of some in the figure of the constellation are mentioned. Bradley first designated stars by their numbers in the constellations according to the lists in Flamsteed's Catalogue, and this was naturally followed by others for the stars which have no special name or Bayer letter.

Yours faithfully,

W. T. LYNN.

Blackheath, 1898, Feb. 23.

PUBLICATIONS.

DAS WELTGEBÄUDE *.—A work in German and printed in German characters—and yet, despite this almost criminal act of Dr. Meyer, we are compelled to admit that it is one of the best expositions of popular astronomy it has been our pleasure to peruse. Modern English works have tended, more or less, to treat of Astronomy in parts; this cannot be said of the present volume, as a glance at the contents enumerated below will show. The English reader can be quite satisfied with the illustrations and afford to ignore the cabalistic text. He will find over 300 of these, 10 being very fine charts, and 31 are coloured. The volume is large, but not inconvenient. There is a brief review of the history of astronomy, and then the refraction and the reflection of light is dealt with. This leads to the principle of the telescope and eyepieces, giving an opportunity to introduce pictures of Lord Rosse's reflector, Herschel reflector, the long focus telescope of Hevelius, and the Lick and Chicago refractors, with views of Lick, Etna, and Nice. Then follows a chapter on photography, amply illustrated by photographs of the Moon, the corona, Jupiter (Harvard), the solar surface (Meudon), and a good plate showing the trails of circumpolar stars. In the section devoted to Photometry is a description, with plate, of Zollner's photometer. Spectrum analysis is next dealt with, and here are some very finely coloured spectra and a representation of the Potsdam spectroscope. In the description of the heavenly bodies the Moon is taken first, and here we have the Lick photographs, a chart of the Moon, several drawings by Hevelius and others. The most complete chapter, however, is that devoted to Mars, in which the illustrations are profuse. Comets, meteors, and meteorites follow, the Sun coming last. Here are reproduced Hale's (Kenwood) photographs of the chromosphere, prominences, and faculæ, some of the Meudon sun-pictures, Greenwich curves showing the magnetic storms of 1892, Feb. 12 and 13, and the sun-spot curves. This completes the first half of the volume. The next opens with three very fine charts of the sky: (1) the northern hemisphere; (2) the southern hemi-

* 'Das Weltgebäude. Eine gemeinverständliche Himmelskunde, von Dr. M. Wilhelm Meyer.' Leipzig und Wien, Bibliographisches Institut, 1898.

sphere; (3) the equatorial region 32° each side of the Equator; a catalogue of mean places of 130 stars for 1900, and examples of stellar spectra. The plate exhibiting the classes of stellar spectra is the best we have seen. Then we have a large number of nebulae and clusters by Roberts, Barnard, Russell, Wolf, and Trouvelot. The Milky Way has a chapter to itself, and here full advantage has been taken of recent photographs by Barnard and Russell. The charts of Sidney Waters showing the distribution of nebulae and clusters are beautifully reproduced. These are followed by chapters on double and variable stars, micrometric and meridian observations, wherein Dr. Meyer introduces photographs of the Poulkova 32-inch refractor, the eye-end of the Lick 36-inch, with plans of the Vienna and Nice Observatories. In the chapter on the Earth the variation of latitude is fully illustrated, and a photograph of the Greenwich Observatory showing the clock is appropriately introduced in the chapter on Time.

Eclipses, Transits of Venus and Mercury, Systems of Cosmogony, Aberration, Precession, Proper Motion, and Motion of the Sun in space bring us to the end.

The printing and paper are above the average, the illustrations are new and profuse, and evidently obtained first hand. We confidently recommend this as being a work in which illustrations of typical advances in every branch of astronomy are collected.

PROF. TODD'S 'NEW ASTRONOMY' *.—The title outside this book is a little misleading, for the expression "New" Astronomy is generally used to imply only the branches of the science to which the spectroscope and the photographic plate are the chief instrumental adjuncts. But Prof. D. P. Todd's volume is a text-book of all branches of astronomy written in a *new* fashion. The novelty may be judged from this extract from the Preface: "Written purely with a pedagogic purpose, insistence upon rightness of principles, no matter how simple, has everywhere been preferred to display of precision in result. To instance a single example: although the pupil's equipment be but a yardstick, a pinhole, and the rule of three, will he not reap greater benefit from measuring the Sun for himself than from learning mere detail of methods employed by astronomers in accurately measuring that luminary?"

And so Prof. Todd explains simple methods for measuring the Sun's angular diameter by means of the laths of a venetian blind, of using a box fixed on a window as a transit instrument to find the time of day, and so on, illustrated by nicely-prepared pictures. There is a novelty, too, in many of the pictures, for the diagrams of instruments instead of being marked with letters of the alphabet for reference are labelled, so that in the picture of the equatorial it is obvious which is the declination circle, because the

* 'A New Astronomy,' by David P. Todd, M.A., Ph.D. American Book Company, New York. \$1.30.

words are printed round its edge. We hasten to explain, however, that the book is not so elementary as this might lead one to think; it is not a child's book, but it contains a very great deal of information packed into a convenient form. In fact, we have not been able to think of a test question which has not its answer in the book. The only partial exception to this statement is that Prof. Todd has endeavoured to explain Foucault's well-known pendulum experiment to prove the rotation of the Earth, in a *popular* way, with, it seems to us, the usual want of success. We believe this popular explanation to be an impossibility. To refer again to the illustrations, although it is difficult from so many to choose any for especial mention, it may be stated that there will be found in the book the latest photographic successes with the Bruce telescope and by Dr. Roberts, prominences and faculæ by Hale, diagrams of the variation of latitude by Chandler, and of Lockyer's meteoritic theory, from which it may be gathered that this is the book to be bought by the man who takes a general interest in science, and likes to keep himself abreast of its recent developments.

NOTES.

COMET NOTES.—A bright telescopic comet (about 6.5 magnitude) about 2' in diameter, with a strong central condensation, and a tail 1° in length, was discovered by Mr. Perrine at the Lick Observatory on March 19. Numerous observations have been obtained, and the following two sets of elements are given in *Ast. Nach.* 3483:—

	Ristenpart.	Hussey and Perrine.
T	1898 March 18.46 G.M.T.	1898 March 18.67 G.M.T.
ω	48° 47'	49° 2'
Ω	263 16	264 7
i	72 45	72 48
$\log q$.	0.0432	0.0419

Ephemeris for Berlin mid- night.					Ephemeris for Greenwich mid- night.				
R.A.					R.A.				
N. Dec.					N. Dec.				
h m s					h m s				
Apr. 2	22	11	30	30 22	Apr. 3	22	17	32	31 21
4	22	20	14	32 16	5	22	26	24	33 14
6	22	29	12	34 8	7	22	35	32	35 4
8	22	38	24	35 55					

Mr. David Smart has computed the following continuation of the ephemeris from Ristenpart's elements (for Greenwich mid-night). His computations appear to be affected by a small error,

but as there is not time to correct this we print them as they stand :—

	R.A.			N. Dec.		R.A.			N. Dec.
	h	m	s			h	m	s	
Apr. 11..	22	53	4	38° 31'	Apr. 23..	23	54	40	46° 51'
15..	23	12	52	41 38	27..	0	16	24	48 58
19..	23	33	28	44 24	May 1..	0	38	28	50 46

The brightness during April slowly diminishes, being at the end of the month about half that at discovery.

The following elements of Comet 1896 VII. (Perrine) have been deduced by Herr Osten from 24 observations extending from 1896, Dec. 8, to 1897, March 1 (Ast. Nach. 3478). Perturbations by the Earth, Mars, Jupiter, and Saturn have been applied :—

Epoch = 1897 Jan. 9 ^d .0 Berlin M.T.				Probable error.
T	1896	Nov. 24	6657 Berlin M.T.	0.0083
ω	163°	54'	2"	7"
Ω	246	37	12	14
i	13	40	17	14
ϕ	42	47	15	167
μ	550''	90		1.59
Period	2352 ^d .5			64.8

At the next return, in April 1903, the comet will be very unfavourably placed; but it will be well placed at the following return in October 1909.

Ast. Nach. 3482 contains a continuation of the ephemeris of Winnecke's Comet (for Berlin midnight) by C. Hillebrand :—

	R.A.			S. Dec.		R.A.			Dec.
	h	m	s			h	m	s	
Apr. 8 ..	22	54	0	10° 59'	May 18..	1	14	23	3° 26' S.
12 ..	23	10	45	10 14	22..	1	25	27	2 48
16 ..	23	26	53	9 28	26..	1	36	6	2 12
20 ..	23	42	22	8 41	30..	1	46	17	1 38
24 ..	23	57	13	7 53	June 3..	1	56	4	1 7
28 ..	0	11	28	7 5	7..	2	5	26	0 38
May 2 ..	0	25	8	6 19	11..	2	14	26	0 12 S.
6 ..	0	38	13	5 33	15..	2	23	3	0 11 N.
10 ..	0	50	46	4 49	19..	2	31	17	0 32 N.
14 ..	1	2	50	4 6					

The brightness is now steadily diminishing, and by the middle of June is only about one-seventh of that at the beginning of March.

The comet is better placed for observers in the southern hemisphere than for those in the northern.

'Popular Astronomy' for March contains a letter by Mr. Perrine relating to the re-discovery of this comet.

On Jan. 1 it was extremely faint and very small—not over 10" to 15" diameter.

It was again observed on Jan. 21^d 1^h 27^m 18^s G.M.T., in R.A. 16^h 33^m 21^s.65, S. Dec. 8° 26' 30".8.

It was then considerably brighter and larger than on Jan. 1.

Ast. Nach. 3480 contains the following elements of Comet 1822 IV. computed by A. Stichtenoth:—

T = 1822 Oct. 23.7727 Paris M.T.			
ω	181°	4'	38"
Ω	92	44	23
i	127	20	48
$\log q$	0.05884		
e	0.99630		
Period ..	5449	years.	

The Comet 1892 II. was erroneously described last month as being discovered by Swift. It was in reality discovered by Denning.

Making use of approximate elements (perturbations have not been allowed for), Mr. David Smart has computed the following search ephemeris of Encke's Comet, which passes perihelion on May 24 next. The ephemeris is for Greenwich midnight:—

		R.A.			N. Dec.			R.A.			Dec.
		h	m	s				h	m	s	
Mar.	18 ..	0	47	8	11 50	June	1..	6	10	2	18 18 N.
	22 ..	0	56	16	12 44		5..	6	25	21	15 11
	26 ..	1	5	36	13 44		9..	6	39	15	11 33
	30 ..	1	15	12	14 39		13..	6	53	14	7 11
Apr.	3 ..	1	25	40	15 39		17..	7	10	3	1 35 N.
	7 ..	1	37	4	16 42		21..	7	28	32	5 2 S.
	11 ..	1	48	4	17 44		25..	7	52	1	13 54
	15 ..	2	1	48	18 47		29..	8	30	49	24 48
	19 ..	2	15	40	19 51	July	3..	9	24	26	36 56
	23 ..	2	30	36	20 51		7..	10	41	47	47 40
	27 ..	2	47	24	21 57		11..	12	15	7	52 7
	30 ..	3	3	20	22 48		15..	13	41	0	54 7
May	4 ..	3	23	12	23 40		19..	14	43	56	52 11
	8 ..	3	45	24	24 18		23..	15	27	16	49 33
	12 ..	4	9	20	24 49		27..	15	57	24	46 56
	16 ..	4	35	20	24 46		31..	16	18	58	44 36
	20 ..	5	4	38	24 7	Aug.	4..	16	38	1	42 38
	24 ..	5	28	48	22 58		8..	16	55	10	41 4
	28 ..	5	51	30	21 3		12..	17	3	32	39 29
							16..	17	13	40	38 13 S.

The comet is not well placed for European observers at this

return, but after perihelion passage it is well placed for observers in the southern hemisphere; it is brightest about July 3 next, when its distance from the Earth is only some 23 millions of miles.

A. C. D. C.

GREAT MAGNETIC DISTURBANCE AND SUN-SPOTS IN MARCH.—The solar photograph taken at Greenwich on March 10 (which was the first obtained after a cloudy period) revealed the existence of a comparatively large group of sun-spots at about mean lat. 12° south, which had then advanced nearly to the central meridian. The group on March 10 stretched in heliographic longitude from 6° to 24° east of the central meridian, so that it may be considered to have passed the meridian a little after noon on March 11. Its total area was roughly estimated at 700-millionths of the Sun's visible hemisphere. On the afternoon and evening of March 11, active minor magnetic disturbance was recorded on the horizontal force and declination photographs. The major disturbance began to be actively shown on the night of March 14 at about 9^h P.M., gradually becoming large during the night of March 14–15, culminating on the night of March 15–16, and dying away at or about 8^h A.M. on March 16. The extreme range of disturbance in declination amounted to $1^{\circ} 21'$, and the disturbance in all elements was the greatest that had been experienced since the great disturbances of 1892 July and August. It is recorded in the "Daily Weather Report" of the Meteorological Office that on the night of March 15 brilliant aurora was seen all over the northern half of the kingdom and also in Denmark. The group seems to be a re-appearance of that which was seen in February, when this part of the Sun was previously visible, and it was also seen as a very small spot on the day of the solar eclipse; its return at the next rotation, therefore, will be looked for with much interest.

W. C. N.

THE CONSTANT OF ABERRATION.—The number of astronomical determinations of this constant is increasing with remarkable rapidity, but not more rapidly than the importance of the subject warrants. We cannot do more than briefly give the results of some recent researches. M. A. Gratschen was good enough to send us some months ago the result of a research on the variation of latitude of Kazan in 1892, 1893, from which there results as a bye-product a value of the constant of aberration equal to $20''.4706$ with a probable error of $\pm 0''.00678$. A series of observations for a similar purpose made by M. E. Fergola at the Royal Observatory, Capodimonte, which was made in conjunction with the series at Columba College, New York, gave $20''.533$. The most recently published value is by Prof. Doolittle, who, in view of the present interest in the values of astronomical constants, gives in *Ast. Journal*, No. 428, a merely preliminary result of an investigation by Küstner's method made at the Flower Observatory, Penn-

sylvania. His result is as large as Mr. Finlay's recently published result, in fact they nearly agree, $20''.572 \pm 0''.009$.

The above results look sufficiently discordant and cast considerable doubt on the present accuracy of Struve's classic value of $20''.445$. In *Ast. Journ.* 427, Prof. Chandler publishes a timely and thoughtful article on this subject, using the fact of such discordant values as a text whereby to point out the futility of selecting at present a value of the aberration constant which is to be considered final.

ON CERTAIN FORMS OF PERSONAL EQUATION.—Prof. T. H. Safford has been continuing his researches on the personal equation as applicable to observations of transits chronographically and by the eye-and-ear method. Writing on this subject in the December number of the 'Monthly Notices' he gives the "reaction-time" for different senses, which appears to be the time taken by the nerves to transmit a sense impression to the brain, as found by psychologists. This time was found by Wundt to be, in the case of an average person, for the sound sense $0''.167$, and for the light sense $0''.222$. It occurs to one that a simple form of observation in which these quantities are factors is the observation of occultations of stars. In these the observer listens to the clock-beat as he looks at the star, and the senses of hearing and sight may be considered the only apparatus employed, and from the above reaction-times the average person should always record the time of a disappearance too late by $0''.055$; but since the word "average" is employed it may be inferred that in some persons these reaction-times differ considerably from these values in both directions, and hence there is room for considerable difference in the recorded times of an occultation by two observers. There are not a large number of such duplicate observations from which this could be investigated, but one can find instances of consistent difference between the same two observers of perhaps $0''.2$ or $0''.3$; but we are quite aware in writing this that there are other causes for such differences than those suggested above.

OBSERVATION OF AN OCCULTATION BY PHOTOGRAPHY.—Since the preceding note was written we have seen a description ('Harvard Circular' No. 26) of a plan for adapting the photographic plate to the observation of occultations of stars. The plate, carried (we presume) by an equatorial driven by clockwork to follow the star, is moved automatically every second by an electromagnet. A motion of about 0.03 cm. is given to the plate whenever the circuit is closed, and of an equal amount when it is opened. The time during which the circuit is closed is given as $0''.06$, so that during this short interval the star impresses a comparatively faint image on the plate. During the remaining 94-hundredths of the second the plate has a different position, and the star impresses a brighter image. The plate then moves, and

this is repeated, so that in the result one gets a line of images of the star, alternately bright and faint, to each of which a definite time can be assigned, since the opening and closing of the electric circuit is effected by the standard clock.

To explain the method of interpretation it will be best to follow Prof. Pickering's actual observation. The star was 26 Arietis, magnitude 6.1. The last image shown on the plate was a bright one, corresponding to the position which the plate had from $50^{\circ}06'$ to $51^{\circ}00'$. Since the image is quite as bright as the others, the star could not have begun to diminish much before the time $51^{\circ}00'$. If the star had disappeared at $50^{\circ}09'$ the last image would be 0.12 of a magnitude fainter than the others, which difference would have been easily measurable. If it had not disappeared until $51^{\circ}06'$ the next image would have been visible, so that the time is fixed in this particular case to within a tenth of a second. It seems that the principle in the general case would be to measure the brightness of the last image relatively to the others, and so infer at what fraction of a second after the last movement the star disappeared.

STELLAR PARALLAX AND PROPER MOTION.—The following list, given in *Ast. Nach.* No. 3483, is the result of a series of observations made during the years 1887–92 by Herr Bruno Peters with the Leipzig heliometer for proper motion and parallax:—

Star.	P. M.	Parallax.	Star.	P. M.	Parallax
η Cassiopeia.....	$1^{\circ}20'$	$+0.18''$	θ Ursæ Maj.	$1^{\circ}11'$	$+0.09''$
μ Cassiopeia.....	$3^{\circ}74'$	$0.13''$	O.A. 10603	$1^{\circ}45'$	$0.17''$
Lalande 15290	$1^{\circ}97'$	$0.02''$	β Comæ.....	$1^{\circ}20'$	$0.11''$
" 18115 <i>p</i> ...	$1^{\circ}97'$	$0.18''$	γ Aquilæ.....	$0^{\circ}96'$	$0.06''$
" 18115 <i>f</i> ...	$1^{\circ}97'$	$0.18''$	Bradley 3077	$2^{\circ}08'$	$+0.13''$
" 18115 <i>m</i> ...	$1^{\circ}69'$	$+0.18''$			

MR. LYNN asks us to point out that the lists given of remarkable meteoric showers which have been seen about the end of the first week in April seem to overlook the record of one which was witnessed at the time of the birth of Mohammed. The date of this, according to Sprenger, in his 'Life of Mohammed, from Original Sources,' was probably April 13 in the year A.D. 571, when that day would correspond to April 23 now. The earliest date in Quetelet's table is A.D. 401, when a "very remarkable" shower was noticed in China on April 6, corresponding to April 21 N.S.

THE reputation, as a practical astronomer, of the second Earl of Macclesfield is well known, and also that he had an observatory at Shirburn Castle. His instruments have recently, by permission of the family, been brought to London by Sir Ernest Clarke, who was interested in them as an antiquarian, and exhibited them privately at the rooms of the Royal Agricultural Society, 13 Hanover

Square. We believe that a publication relative to them is being prepared.

WE were pleased to see Mr. Burckhalter, of the Lick Observatory, who called at the Royal Observatory on his way home from India, where he had been to observe the recent eclipse. His arrangement of a revolving fan to give times of exposure to different parts of the corona proportionate to their brightness seems to have been a success.

A SPECIAL Meeting of the Royal Society was held on the afternoon of Thursday, March 31, to hear preliminary statements of the results of observations of the recent solar eclipse. Communications were made by the Astronomer Royal, Sir Norman Lockyer, Prof. Turner, Cpt. Hills, Dr. Copeland, and Mr. Newall.

MR. BURNHAM informs us that he is making a comprehensive catalogue of all the stars he has discovered, arranged in order of Right Ascension. He will be pleased to receive any unpublished measures of these stars to incorporate in this.

WE hear, just as we go to press, that Prof. J. E. Keeler has been appointed Director of the Lick Observatory *vice* Prof. Holden resigned.

FROM AN OXFORD NOTE-BOOK.

THE Report of the R. A. S. Council for 1897 is of noble dimensions (141 pages), the largest yet published with the exception of 1893 (155 pages). This shows the zeal of Mr. Knobel and Mr. Dyson, who have done the work this year in the absence of the Secretaries on the eclipse expedition. It is not often that an eclipse occurs in January, and the Secretaries were clearly right in taking advantage of so plausible an excuse for getting some one else to do the heavy work of the Report for them: and that they were lucky enough to get the right men for substitutes is abundantly shown by the result. Mr. Knobel, being Treasurer of the Society, was doubtless keeping one eye on the printing bill, or the record of 1893 would have been beaten. This record was created by the ardour of two new Secretaries, and was 18 pages longer than the previous year, and over 30 longer than any other year up to that time; but, apparently somewhat exhausted by their maiden effort, the youthful pair dropped to 107 and 104 in the following years. There seems little doubt that Mr. Dyson, with a kindred spirit (I beg Mr. Knobel to understand that I am only referring to that eye on the printing bill), would have outclassed 1893 altogether. I trust the Secretaries have had the grace to express their warm appreciation of what has been done for them.

ONE of the objects of the foregoing paragraph is to lead up to the question, without taking it too seriously, whether these

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reports show any tendency to become too long. They have certainly become longer in the last 20 years, as a few figures show. Dividing the years 1879-1898 into four groups of 5 years each, the average number of pages in the report for each group is 109, 125, 125 respectively. These figures must not be taken mean too much: accidental circumstances, such as the death of a distinguished Fellow, lengthen the report considerably; while the non-award of a medal shortens it. [The third of the above groups (1889-1893) has obituary notices of Airy and Adams; but only three Presidents' Addresses instead of five, so that the accidental circumstances tend towards compensation.] But there is no doubt of the increase in the length of the Report. Is this increase justified by events? If it is due to the rapid development of the photographic method, and the recent establishment of great observatories and large telescopes, I think we shall admit that there is a real historical reason for the lengthening of the Report. But it is easy to determine this point by considering the sections separately.

To take first the 'Notes on the Progress of Astronomy,' in which such a development as that in photography or in the number of large telescopes would naturally show itself. The average numbers of pages for the same groups of years as before, viz., 1879-1883, 1884-1888, 1889-1893, 1894-1898, are 31, 26, 33, 33 respectively. The first is a little exceptional, since the year 1879 contains a note of 22 pages on meteors, the last of a series of such notes, which had gradually become very long and were discontinued in 1880. [Similar numbers for five-yearly groups 1869-1873 and 1874-1878 are 22 and 43 pages respectively.] If we omit this note, the numbers for the four groups would be 26, 26, 33, 33, showing an increase of 7 pages—not perhaps extravagant under the circumstances above mentioned.

THE figures for the Reports of Observatories are 18, 21, 30, 33: the steady advance is clear enough, the material having nearly doubled in fifteen years. The reasons are several: more trouble has been taken by Mr. Wesley to get reports from Colonial observatories; there are more private observatories; another Royal Observatory at Edinburgh has been built; and finally the introduction of photography into the larger observatories makes their reports necessarily longer. Thus the average numbers of pages in the Greenwich report in the four periods were 2.1, 3.4, 4.5, and 5.0 respectively: the Cape Report, always just a little longer, averaged 2.6, 4.3, 5.4, and 5.0 pages (it was very near losing its pride of place in the last period, but by a great effort of 8 pages in 1898 managed to run a dead heat). Both these reports have doubled in sympathy with the whole section, and are responsible between them for 5 of the 15 pages increase in 15 years. But the merest glance at the successive

reports will show how real an increase in activity they represent. The doubling at Greenwich, for instance, has not been confined to the R. A. S. Report. The number of instruments in the place has been doubled, and the number of chronometers, and the number of observations, and the buildings, and even the Chief Assistant.

Finally, as regards the Notices of deceased Fellows the figures are 20, 22, 27, 22. (It has already been remarked that notices of Airy and Adams occur in the third group.) These show no appreciable increase, and even going two periods further back we get much the same figures, viz. 23 and 21. The total numbers of losses by death to the Society in the six consecutive periods were 63, 69, 82, 90, 74, and 90 respectively, figures which do show some progressive increase, sufficient perhaps to account for a page or two more in the section. We may regard this section of the report therefore as tolerably stable in length and character; though perhaps a little more has been done in recent years to get some few details about the obscurer Fellows, though it be but a couple of lines and a date or two. [This is not always possible, especially in the case of "compounders," who change their address without any intimation.]

The President's Address and the tabular statements occupy 29, 40, 35, and 37 pages on the average in the four periods; I give these figures with no comment. Thus the increase of 27 pages from the 98 of the period 1879-1883 to the 125 of the present time is to be found mostly in the Reports of Observatories (15 pages) and in the Notes on Astronomy (say 4 or 5 pages); and in both cases there seems good reason for the increase, if the Report is to keep pace with the times.

The printing bill may no doubt become an anxiety; for the number of Fellows and the income of the Society do not show any sensible increase, and the margin of income over expenditure is not large. Still at present it is a positive quantity, and there is no need to meet troubles halfway.

THE mention of the Cape Observatory above reminds me of two things. The first is that I had the pleasure of receiving a few days ago a letter from the veteran astronomer Otto Struve containing the following sentence:—"To-day (1898, March 20) I have spent the whole morning in perusing the (R.A.S. Council) Report and have been very much interested by the information I gained thereby of the state and progress of Astronomy in Great Britain. The activity of the Cape Observatory under Gill's direction is really astonishing and admirable."

There must be many who will be glad to hear that Dr. Otto Struve is in excellent health, though within a few weeks of his 80th year. He proposes to spend the summer with his children and grandchildren near St. Petersburg, staying some days on the way thither from Karlsruhe at Königsberg with his son Hermann; and it will be also welcome news to astronomers that the latter

hopes to publish his work on the Saturnian System about July next.

THE second point is that among the beautiful star-spectra obtained by Mr. McClean during his stay at the Cape last summer is one of exceptional interest. The spectrum of β Crucis contains lines which seem to be those of oxygen. This announcement has been made to the Royal Society (see 'Nature,' Feb. 24), and the plates of spectra which are being prepared for publication will enable those interested to appreciate the evidence for themselves. I may say that I was recently permitted to examine not only the enlargements but one of the original negatives; and the evidence seemed to me quite convincing. My knowledge of spectroscopic work is so slight that it may seem an impertinence to offer this opinion: but the question of identifying lines with tabular wavelengths is after all not very different from that of measuring the photograph, about which we have most of us had to learn a little lately.

THE following extract is from a book—an excellent book—on 'Style,' by Walter Raleigh (London: Edward Arnold, 1897). It is rather long for these notes, but cannot well be shortened; and I think it concerns us:—

The greater men of science have been cast in so generous a mould that they have recognized the partial nature of their task: they have known how to play with science as a pastime, and to win and wear her decorations for a holiday favour. They have not cruciated the fulness of their faculties in the name of certainty, nor cramped their humanity for the promise of a future good. They have been the servants of Nature, not the slaves of method. But the grammarian of the laboratory is often the victim of his trade. He staggers forth from his workshop, where prolonged concentration on a mechanical task, directed to a provisional and doubtful goal, has dimmed his faculties; the glaring motley of the world, bathed in sunlight, dazzles him: the questions, moral, political, and personal, that his method has relegated to some future of larger knowledge, crowd upon him, clamorous for solution, not to be denied, insisting on a settlement to-day. He is forced to make a choice, and may either forsake the divinity he serves, falling back, for the practical and æsthetic conduct of life, on those common instincts of sensuality which oscillate between the conventicle and the tavern as the poles of duty and pleasure, or, more pathetically still, he may attempt to bring the code of the observatory to bear immediately on the vagaries of the untamable world, and suffer the pedant's disaster. A martyr to the good that is to be, he has voluntarily maimed himself "for the kingdom of Heaven's sake"—if, perchance, the kingdom of Heaven might come by observation. The enthusiasm of his self-denial shows itself in his unavailing struggle to chain language also to the bare rock of ascertained fact. Metaphor, the poet's right-hand weapon, he despises: all that is tentative, individual, struck off at the urging of a mood, he disclaims and suspects. Yet the very rewards that science promises have their parallel in the domain of letters. The discovery of likeness in the midst of difference, and of difference in the midst of likeness, is the keenest pleasure of the intellect; and literary expression, as has been said, is one long series of such discoveries, each with its thrill of incommunicable happiness, all unprecedented, and perhaps unverifiable by later experiment. The finest instrument of these discoveries is metaphor, the spectroscope of letters.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

MAY, 1898.

No. 266.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Wednesday, April 6, 1898.

Sir R. S. BALL, LL.D., F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. TURNER, M.A., B.Sc., F.R.S., and
H. F. NEWALL, M.A.

THE Minutes of the previous Meeting were read and confirmed.

Mr. Newall. Since the last Meeting 67 presents have been received. If I may select any for special mention, I will call attention to a Catalogue by Mr. Stanley Williams, which gives the magnitudes of 1081 stars lying between 30° S. Dec. and the South Pole, deduced from observations made during a journey to Australia in the years 1885-86; to volume xii. of the publications of the Potsdam Observatory; and also to the twenty-second volume of the 'Annals of the Paris Observatory,' which contains a selection of valuable memoirs: we have also received from Paris the second part of the Photographic Atlas of the Moon now being made by MM. Loewy and Puiseux, which contains photographic reproductions of various lunar regions with text describing them. The Astronomer Royal has presented transparencies of his Eclipse photographs, and we have also received a transparency and a print made from a negative taken during the recent eclipse on January 22 by Mr. Thwaites.

The President. We have still to hear several accounts of eclipse expeditions, supplementing those we had at the last Meeting; and I will first call on Mr. Maunder to show his photographs and to tell us about his observations of the zodiacal light.

Mr. Maunder. My wife and I, when we resolved to go to India, had but a very small photographic equipment. It was limited to a small camera which had an objective of 1½ inches aperture and 9 inches focal length. The image of the Sun in the primary focus would therefore be one-twelfth of an inch in diameter. It was,

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therefore, a matter of the most anxious consideration for us as to whether there was anything we could do which would be of any value, and which would not be a mere repetition on a microscopic scale of what would be done very much better by the observers sent by the Committee. There were two ideas which struck us that we might attempt to carry out, but for these we needed an equatorial. Here the Council of the R. A. S. came to our help, as it was good enough to lend me the equatorial which our late lamented Fellow, Mr. Sydney Waters, had constructed for his use in Norway. With the equatorial there was a camera which, though quite unsuited for the special work we proposed to undertake, might, it seemed to us, be used with our own little camera upon a third line of work. We might, by its assistance, make a series of graduated exposures on the corona, with a view to getting a better idea of what was the best exposure for it, for it seemed to us that there was still some amount of uncertainty upon this point. Mr. Albert Taylor in 1894 communicated a paper to the Royal Dublin Society in which he laid down the *maximum* for effective exposure with rapid plates as 30 seconds for $f/15$. So, taking that as our maximum limit, we arranged a series of five exposures in a geometrical progression with a common ratio of about $4\frac{1}{2}$. That made our shortest exposure $1/400$ of the longest. We carried out that series of exposures in duplicate pretty nearly successfully. [Photograph taken with Mr. Waters's camera shown on screen.] The aperture I used with Mr. Waters's camera was $1\frac{1}{2}$ inch, focal length about 8 inches, and in the primary focus the image of the Sun is $\frac{1}{3}$ inch. It is enlarged in the camera some 11 or 12 diameters by a telephotographic lens. Bearing in mind the minute scale of the original image and the high magnification employed, I think a careful examination of the slides will convince you that Mr. Dallmeyer, who made the camera, has carried out his work with all his traditional skill. There is a very large amount of detail on this little picture. The second line of work we resolved to carry out was with our own camera, and there the image was taken in the primary focus. We received our instrument at our camp on the afternoon of Friday, January 7. Early next morning, about 5 o'clock, there was a partial eclipse of the Moon. We had not time to put up the instrument, but I put the camera on a chair, and obtained a set of exposures of the commencement of the eclipse. The camera was not then sharply in focus, but the shadow can be plainly seen creeping over the Moon. The first special work that we tried with our own camera was to get the corona extensions if we could. For this purpose we gave exposures four times as long as the extreme limit in Mr. Taylor's paper, and we were successful in tracing the corona further than it has ever been traced before. The next slide shows the longest exposure. There is no difficulty in tracing the corona for quite six diameters from the centre of the Sun. One other attempt we wished to make was to see if we could get the corona after the

return of sunlight. Nearly two minutes after the return of sunlight we exposed a plate, and here [picture shown on screen] we have, beside the arc of sunlight, the entire dark disc of the Moon quite distinct, surrounded by a distinct ring of the corona. I think it is the first time that the corona has been unmistakably photographed in so large an amount of sunlight. Though these photographs are on a very microscopic scale, yet they suffice to prove the practicability of the attempts we made, and we should like to follow them up at the next eclipse, only with very much more adequate means.

There are a great number of questions which one would like to ask after a photograph of this description. We greatly desire to photograph the next eclipse from the beginning to the end through all its partial phases, so as to see what is the actual limit of sunlight in which it is possible to obtain an image of the corona. We wish to vary exposures and developments to ascertain the best conditions, and, above all, we hope that from some source or another we may be entrusted with a sufficient instrumental equipment to carry out our scheme on a reasonable scale.

One of the very first things that we were struck with on our voyage outwards was the great brilliancy of the zodiacal light. To the best of my memory I have only seen it four times in England, and then only in the spring-time; but by the time we got to the Red Sea in going out, we found the zodiacal light was a very brilliant object. On December 22 I made the first systematic observations of its outline, defining it by stars in its neighbourhood, and recording whether its outline passed through the star or so many degrees north or south of it. Though the light faded away at either border, its outline was sufficiently definite to enable these observations to be made. The first series of observations were commenced on December 22, and carried on for the next three or four nights. On January 15 I commenced another series of observations. On the return voyage on February 16 and the following nights I observed the evening branch again. The eastern or morning branch is in many ways the more interesting, but unfortunately I only observed that on two occasions on the outward voyage. While we were in camp at Talni the Moon interfered with it. On the homeward voyage, though I got up every morning, it was cloudy or foggy or misty every time. There was a curious difference between the two branches. The zodiacal light as seen in the evening was symmetrical with the ecliptic. The eastern or morning branch was distinctly inclined to the ecliptic and above it. It puzzled me extremely to find out any theory which would account for all the features which the zodiacal light presented to us; but it seemed to me that most of its characteristics might be accounted for if we supposed that the Sun was surrounded by a series of rings of minute particles, like those of Saturn, but far more sparse, and that the Earth was placed in the centre of a

broad division corresponding to the Cassinian division of the Saturnian system.

The President. As we have some other communications with respect to the eclipse, it will be convenient to postpone discussion of this till after we have heard these others.

Mr. Newall. I will begin without more general preface by mentioning the lines of research set before me for the eclipse. The first was to attempt to determine by spectroscopic observations whether the corona rotates about the solar axis. This attempt was unsuccessful, for the photographic plate which was exposed in the spectroscope shows no sign of having been affected by the light of the corona. The method of observation was, roughly speaking, to get two spectra—one of the eastern equatorial region of the corona and one of the western—placed close together on the photographic plate so that one could detect any displacement of corresponding lines in the two spectra which could be attributed to motion in the line of sight, and hence that a period of rotation of the corona might be deduced. The failure of the photograph is without doubt to be attributed to the faintness of the corona in the region which I attempted to photograph. The photographs of the spectrum of the corona taken by Capt. Hills at the same station, Pulgaon, in Central India, show unexpectedly small radial extension. In neither of his photographs is the spectrum traceable further than about 4' from the limb of the Moon. As I attempted to photograph the spectrum of the corona 8' from the limb, my photograph was unsuccessful, and I feel sure I shall have the sympathy of those who have undertaken observations of this sort where the trouble of preparation beforehand is very considerable.

The second line of research undertaken was a visual observation of the distribution of glowing "coronium," the hypothetical element to which the green line of the corona is attributed. I observed the corona in fact in the homogeneous green light emitted by this unknown element. The results are represented in the diagram on the board. I will give an outline of the method I adopted to get these results. I used an objective grating spectroscope, using the spectrum of the second order; and keeping myself intentionally ignorant of the orientation of the image until the observations were completed, I made a diagrammatic drawing, during the eclipse, of what I saw. The coronal ring was, in consequence of the adjustments of the instrument, distorted into elliptical shape, with the minor axis parallel to an hour-circle. The ring was seen with such brilliancy as to leave no doubt in my mind that it could have been photographed on this occasion; but as there had been a doubt on previous occasions whether any attempt to photograph it would be successful, I determined to make visual observations. My point was to see whether the fine radial structure, which is characteristic of the photographs of the corona, could be seen in this homogeneous green light. I specially

looked for it, and failed to detect any region round the ring where this fine structure could be seen; but I saw broad patches of light in the different positions shown in the diagram, and I have summed up the observations in 10 statements. The ring was visible all round the limb of the Sun, and there was no place where the light was absent. The result of the observations is that glowing coronium is visible all round the limb. The luminosity is not uniform round the limb. No fine radial streamers were seen near the poles of the Sun, such as are seen in ordinary direct photographs. The fourth point was that patches of increased luminosity were visible; seven bright patches were noted. In several cases the extension was considerably greater in radial direction than in the tangential direction. Two of the long streamers extending 12'-14' from the limb were found to coincide with the position of obvious extensions of the corona. In the case of another such streamer, no such coincidence occurred. There is no clearly-shown relation between the bright patches of the "coronium" and the prominences visible on the limb. That practically is all I need now say about the distribution of the "coronium" in the corona; I gather from the experience that it would have been easy to photograph it with an objective grating telescope.

The third line of research was an attempt to trace faint extensions of the corona with the aid of a polariscope; but the polarization of the atmosphere was so unexpectedly great that at a glance it seemed to me hopeless to see these extensions, so I gave up the attempt and determined to go on with an alternative exploration, which was chiefly for the purpose of orienting myself in the nature of the polarization-phenomena to be investigated during an eclipse. The thing which struck me most was the great intensity of the atmospheric polarization.

The fourth line of research was an attempt to photograph the bright lines in the spectrum of the Sun's limb at the end of totality. Using the same slit-spectroscope as was employed for the first investigation, I managed to catch the spectrum of the "flash" at the end of totality. I hope to get some good determinations of the wave-lengths. The "bright-line" spectrum obtained is not simply a reversal of the Fraunhofer solar spectrum. It is similar to that got by Capt. Hills at the same station, and also to those obtained by Sir Norman Lockyer's party at Vizidurg, and also to that obtained by Mr. Shackleton at Novaya Zemlya in 1896, so there is little doubt that the spectrum is to be found at all points round the limb of the Sun, and is not a chance spectrum got from what is known as a metallic prominence in the Sun.

The Astronomer Royal. At the last meeting, as may be remembered, I gave a short account of the expedition to Sahdol, and the results I had obtained in the way of photography of the corona, and also of photographs of the partial phase of the eclipse for the determination of the Moon's position; but as my baggage had not then arrived in London, I was only able to show two positives

I had taken from my eclipse negatives, which were not very satisfactory reproductions. To-night I am able to show some which will give a better idea of the general character of the series of negatives obtained. This first photograph which I show was taken with a short exposure of one second, 6 sec. after totality, with the idea of showing the prominences and the inner corona. My object was to get a series of photographs with exposures ranging from a very short exposure of $\frac{2}{3}$ sec. to 20 secs., so that one could build up, as it were, the detail of the corona from the Sun's limb outwards so far as the limit of my field would allow, that is 10 inches, representing $2\frac{1}{2}$ diameters of the Sun, the Sun's diameter being 4 in. The first photograph of the series was taken at the beginning of totality, and another with an exposure of $\frac{2}{3}$ sec., 14" before the end, both of them showing the prominences and the lower part of the corona. The photograph taken with the longest exposure of 20 secs. shows the corona as well as I could get it. One point which strikes me is the connection between the coronal structure and the three prominences in the photograph taken with an exposure of 5 secs. There are three distinct branches seeming to stream from these three prominences, and other prominences on the Sun's limb appear also to be associated with extensions of the corona, but on this point it may be well to point out that even if coronal streamers in all cases were connected with prominences, it does not follow that the prominence should always be seen on the photograph, because it may not be exactly at the limb.

The photograph which I next show on the screen was taken with an exposure of 10 secs., and is more fully developed. Besides these pictures of the corona, I also took a series of photographs from which I hope to determine the positions of the Moon relatively to the Sun; this is, I believe, the first occasion on which photography has been applied to this purpose. [A series of photographs of the partial phases of the eclipse were shown on the screen.] There were three groups of spots on the Sun at the time of the eclipse, which is rather remarkable at this phase of the sun-spot cycle, and I have thought it may be found of interest to show the record of the magnetometers at Greenwich just prior to eclipse. It is worth remarking that from Jan. 15 to Jan. 21—the eclipse was on Jan. 22—there was a series of disturbed days, so far as the magnets were concerned, recorded at Greenwich, which was quite unusual; it would be difficult to pick out from the whole of 1897 twice that number of disturbed days; and these days occurred continuously one after another, so that there was an unusual state of magnetic activity about the time of the eclipse, and it seems to me not without interest to consider this in connection with the solar activity as shown by the sun-spots and by the form of the corona.

Prof. Turner. I wish to make some remarks about the very steady and somewhat unusual conditions of temperature at Sahdol.

The curve thrown on the screen is the weighted mean of a few days near the eclipse, especially January 21st and 23rd. The minimum occurs about 7 o'clock in the morning. The Sun rose about 6.30, and almost directly afterwards up went the temperature from 38° to 80° , which it reached at 3 o'clock in the afternoon, and when the Sun was nearly setting there was a correspondingly sharp fall. Between 5 and 6 o'clock the temperature fell from 55° to 65° , or 10 degrees in an hour. An error of 5 minutes in reading the thermometer thus makes an error of a considerable fraction of a degree. Our native assistants worked with a will, but our meals were a little irregular, and it is possible that some of the very small variations from this mean curve shown on separate days [diagram on screen] are due to errors in the moment of reading. At the time we arrived at the camp the rise and fall of temperature was more marked than at the time of the eclipse. The range instead of being from 40° to 80° was from 30° to 80° . During the eclipse the thermometers were read every 5 minutes instead of every half-hour. The fall due to the eclipse was 8° in the case of the dry-bulb, and $3\frac{1}{2}^{\circ}$ in the case of wet-bulb. The influence of the eclipse may be traced on the curves up to 10 o'clock at night.

Dr. Stoney described experiments made to illustrate the way in which the dark lines of the ordinary solar spectrum, and the bright lines of the chromosphere, are produced, and which indicate the physical relation in which these lines stand to each other.

The spectroscope employed was one with a flat Rowland's grating of 26,000 lines. The Sun's photosphere was represented by the bright flame of a Hitchcock lamp, fortified by dissolving camphor in the oil, and the Sun's atmosphere outside the photosphere was represented by the flame of a spirit-lamp coloured by sodium, lithium, or other vapours. An image of the Hitchcock flame, presented edgewise, was thrown by a lens on the slit of the collimator of the spectroscope, and produced a bright continuous spectrum. The flame of the spirit-lamp was then placed between the lens and the collimator, so that the light from the Hitchcock lamp (representing light from the photosphere) passed through the coloured flame of the spirit-lamp (representing the Sun's outer atmosphere), before reaching the spectroscope. Arrangements were made by which the temperatures of both flames could be varied within certain limits.

By this experiment it is proved that the sodium vapour, though transparent to most light, is densely opaque to those particular rays which produce the D lines. Accordingly it cuts out those rays which correspond to the D lines from the otherwise continuous spectrum of the representative of the photosphere, and it substitutes in those situations its own fainter light. The sodium lines are then seen as dark lines upon a bright background.

By screening off the Hitchcock flame we see these same lines as bright lines, that is, as they are seen in the chromosphere at the

Sun's limb, where it is without the bright background of the photosphere. It is thus found that the stronger the bright sodium lines when seen without the bright background, the fainter will they be when viewed as dark lines upon that background. By varying the temperatures of the two flames, all the varieties of dark lines seen on the Sun can be imitated, and even the effect of brighter lines on a bright background, like the hydrogen lines in stars of the Vega type, can be reproduced by making the spirit-flame hotter than the Hitchcock, or by substituting a Bunsen's burner for the spirit-lamp.

This experiment explains why the helium line D_3 is not seen as a dark line. In fact its own intrinsic brightness is almost exactly the same as that of the rays of the Sun's continuous spectrum which it has intercepted.

It also explains why Professor Hale found intensely bright carbon lines in the chromosphere, corresponding to the excessively faint dark carbon lines of the solar spectrum, which are a little more refrangible than the magnesium group b .

And it explains the same fact as noticed by observers of the recent eclipse, viz. : that in many cases very bright chromospheric lines correspond to faint dark lines of the ordinary solar spectrum, and *vice versa*.

In making the foregoing experiments, one is struck by the brightness, which it is found may be outstanding in lines which appear dark, and even intensely dark, when projected upon a still brighter background. This is in consonance with the fact that the Sun's chromosphere, though it furnishes very bright lines, can act as a reversing layer where we look through it at the still brighter photosphere.

Capt. Hills. I merely wish to say a few words relating to a Report we have received from the Surveyor-General of India which contains photographs of the corona taken in the north of India by one of the officers of the Survey, Mr. Pope. When the arrangements for observing the recent eclipse were being discussed, we entered into correspondence with the Surveyor-General, and he mentioned that there was an instrument which was prepared for a former eclipse, and that it was available for use. The Eclipse Committee replied that it was desirable that this should be used, and that it should be stationed in the north of India, where the Eclipse Committee were not sending any observers. The instrument has a Dallmeyer lens, of 3 inches aperture, 32 or 33 inches focal length, and has a simple equatorial mounting. The Surveyor-General consulted the Committee as to the kind of plates to be used and other details, and it was recommended that Ilford Empress plates, or the Ilford special rapid, should be used, which were the kinds used at Sahdol and Pulgaon. I do not know that the work calls for any special remarks beyond saying that there is a very nice reproduction of a comparatively long exposure photograph, a good photograph on a small scale which

would have been extremely valuable if all the other expeditions had failed. I think the Society should thank the Indian Survey Department not only for carrying out our instructions as to observations, but also for furnishing a Report so promptly after the event.

The President asked for remarks on the communications.

Dr. Spitta. I should like to ask Mr. Maunder if he backed his plates; and if so, with what? and what was the focal length of the telescope with which the small pictures were taken?

Mr. Maunder. The focal length was 9 inches. The plates were not backed.

Mr. Wesley. With reference to Mrs. Maunder's photographs taken with the small camera, I will throw upon the screen M. Hansky's photograph, which shows the greatest extension that has hitherto been photographed. The long ray is in the N.W. quadrant. On the slide it is easy to trace it as far as $2\frac{1}{2}$ diameters from the limb. There is a diffused marking due to thin cloud, which probably has nothing to do with the corona. The longest ray in 1896 was to the N.W., and the longest ray in 1898 was to the S.W., and that shown by Mrs. Maunder is the longest ray that has yet been photographed. With regard to the Astronomer Royal's photographs, I am much struck with the extreme beauty of the polar rays, which are remarkably definite. They look quite like a mass of reeds growing from the pole, and the conclusion is almost irresistible that they lie one behind the other to an enormous thickness. The Astronomer Royal's remark that there seemed to be a connection between the corona and the prominences, I think is fully justified from the appearances of the photograph. I thought so in 1893, I thought so still more in 1896, and in 1898 the photograph much strengthens my belief. It seems as if the coronal rays were arranged with some regard to the prominences, but I will not go so far as M. Hansky, who thinks that every prominence has its coronal ray.

Prof. Turner. I should like to congratulate Mr. Maunder on getting these extensions photographically. From personal experience in measuring the density of deposit with Capt. Abney's revolving sector, I feel sure, having the large field he has, that he will be able to trace the extensions further by some means of that kind than by the naked eye. I hope he will find the opportunity to submit these beautiful photographs to some test of that kind.

The President. We have heard these communications with very great interest. Many will, no doubt, remember that in that inimitable book Smythe's 'Celestial Cycle,' the author remarks that the astronomer's best possible assistant is his wife. The remark appears to be justified by some of the beautiful photographs we have seen this evening.

The Astronomer Royal made some remarks on a comparison of the Ten Year Catalogue of Stars now in preparation at Greenwich, with certain fundamental catalogues, and also men-

tioned that, notwithstanding the cloudy weather of last winter, Mr. Lewis had succeeded in measuring the small companions of Sirius and Procyon with the 28-inch equatorial.

Dr. Stoney read a report which *Dr. Isaac Roberts* had authorized him to communicate to the R. A. S., describing three attempts made by Dr. Roberts in the present season to photograph the Leonids in the open sky. No trace of the meteors has been found on the photographic plates; but in view of the advance which may be made in meteoric astronomy if the position of the meteors before they reach the Earth can be determined with accuracy by observation, Dr. Roberts is willing to make a further attempt next season if the requisite ephemeris is prepared.

Mr. Newall (introducing a paper by *Rev. W. Sidgreaves*). I wish Father Sidgreaves were here to receive the congratulations due to him for carrying out a very careful examination of the spectrum of Mira Ceti. He determines the wave-lengths of a great number of bands in the spectrum, and also notes the irregularities of the hydrogen lines. The $H\delta$ and $H\gamma$ lines are extremely bright, while the $H\beta$ line (the F line) is a little difficult to make out in the spectrum. He has sent us some slides showing (1) the nature of the spectrum itself, and (2) the comparison of the spectrum with the spectra of other stars, notably β Pegasi, α Herculis, α Orionis, and α Tauri; and (3) a progressive change in the relative brightness of the yellow and blue ends of the spectrum. He finishes his paper with well-considered tables of bright lines and of dark lines, together with the possible origin of a number of the lines he has identified.

The following papers were announced and partly read:—

Rev. W. Sidgreaves. "The Spectrum of α Ceti, as Photographed at Stonyhurst College Observatory."

H. A. Howe. "Observations of Nebulæ at the Chamberlin Observatory, Colorado."

A. F. Lindemann. "A Revolver Eyepiece, Electrically Warmed."

G. Johnstone Stoney. "Note upon how the Bright Lines of the Chromosphere stand related to the Dark Lines of the Ordinary Solar Spectrum."

Isaac Roberts. "Second Attempt to Photograph the Leonid Meteor Swarm."

Royal Observatory, Greenwich. "Comparison of the Forthcoming Ten-Year Catalogue for 1890 with Certain Fundamental Catalogues."

Royal Observatory, Greenwich. "Observations of the Companions of Sirius and Procyon."

A. C. D. Crommelin. "Times of Transits of the Zero Meridians of the two Adopted Systems across the Centre of the Illuminated Disk of Jupiter."

The following gentlemen were elected Fellows of the Society:—

Capt. Vernon L. D. Broughton, Hillside, Godstone, Surrey.

Charles Friswell, 34 Madeley Road, Ealing, W.

Prof. C. J. Joly, M.A., Astronomer Royal for Ireland, The Observatory, Dunsink, Co. Dublin.

William Ritchie, 75 Morningside Road, Edinburgh.

The following Candidates were proposed for election as Fellows of the Society:—

Henry Ellis, Little Heath, Potter's Bar (proposed by J. G. Petrie).

Peter Matthews, Solicitor, 102 Fenchurch Street, E.C., and 65 Gordon Mansions, W. (proposed by Thomas Mackenzie).

Capt. P. B. Molesworth, R.A., Trincomali, Ceylon (proposed by E. W. Maunder).

W. J. Reynolds, 61 Fairholt Road, Stamford Hill, N. (proposed by F. W. Dyson).

William Edward Sparkes, Stockbroker, 5 Roker Terrace, Sunderland (proposed by Cuthbert Hutchinson).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE fifth ordinary Meeting of the Current Session of the British Astronomical Association was held on Wednesday, March 30, at Sion College. *Mr. N. E. Green*, President, in the Chair.

Dr. Isaac Roberts contributed a note on "Espin's Object in Perseus." He remarked that an examination of photographs of the region in question showed that the supposed object is simply one of the numerous spaces amongst the stars in the Milky Way which may be seen on many photographs. Such vacant spaces, *Dr. Roberts* added, had been frequently observed by *Sir W.* and *Sir J. Herschel*, as well as by others, many years ago.

Mr. Maunder then gave a short account of the work of the eclipse party at Talni. The instrument he himself employed was a binocular with a prism fitted in one of the eyepieces, so that with one eye he saw the image of the corona itself and with the other the spectrum of the corona, which, when the dark Moon shut out the Sun, formed its own slit. The object was to ascertain the distribution of the gas they called coronium, and the presence of which was indicated by the line in the green of the spectrum of the corona. During the early part of the eclipse he was not able to see that line at all; but in the latter half he was able to detect it, and he was able to trace it to about 6' from the dark limb of the Moon. He was not able to detect any rifts or rays in it. Of course the corona which he saw with the left eye, with the direct image, showed both rifts and rays; but the green line showed neither, so

far as he was able to make out. That would seem to indicate that the gas which they called coronium was distributed pretty evenly round the Sun, whilst the substance which made up the total image of the corona was probably matter in the form of dust, and such matter, of course, gave a continuous spectrum. The corona was undoubtedly an unusually bright one, and he thought also it was an unusually large one. The spectacle as seen in a binocular was extremely beautiful.

Mrs. Maunder presented a preliminary report on the photographs taken during the Eclipse. Her special object was to obtain photographs of the coronal extensions to a greater distance than heretofore*.

Rev. J. M. Bacon then described the observations made and the results obtained by the party under his charge at Buxar. He wished, in the first place, to refer to the loss of the cinematograph film of the eclipse. The cinematograph telescope, kindly lent by Mr. Nevil Maskelyne, had worked admirably, and he had secured a film of the eclipse as well as two other views. The two latter had come safely home, but the eclipse film was missing, and he could only conclude that it had been stolen. In addition to the photographs of the total eclipse which were taken, his daughter made a series of photographic tests of the return of light after totality. He himself carried out a photographic experiment, comparing the light of the corona with that of the full Moon in England at the same altitude as the eclipsed Sun. Miss Dixon and Miss Bevan, using a slitless spectroscope, noted that at 1^h 32^m the Fraunhofer lines were clearly seen, notably C, D, F, G, of which C and G were specially clear. These were similarly seen after totality, when they remained visible for at least 10 seconds. The Fraunhofer lines disappeared at 1.43, immediately before totality. The phenomenon of the reversing layer was missed at the commencement of totality but seen after totality, when many bright arcs appeared, notably C, D, and F. The line 1474 K was carefully looked for, but not identified. The cone of shadow was seen, appearing parabolic in outline rather than circular. The corona was seen fully 1 second before totality, and afterwards for from 3 to 10 seconds. Three of the sketching party described the coronal light as faintly bluish-white, inclining to amethyst. The fourth, who had not previously shaded his eyes, considered it white. Various photographs by Mr. Bacon and Mr. Thwaites were then shown and a water-colour drawing of the eclipse from a sketch made by Mr. E. Johnson.

Mr. Evershed gave details of his observations of the eclipse †.

Mr. Crommelin exhibited a table giving the ephemeris during April of the comet discovered by Perrine at the Lick Observatory about 10 days previously. He remarked that the comet was now

* See page 186.

† See 'Observatory' for April, p. 154.

well placed and was a very conspicuous object for observers who cared to get up at one or two o'clock in the morning.

Mr. Maunder gave a *résumé* of a paper by himself and *Mrs. Maunder* on the results of their observations of the Zodiacal Light on the outward and homeward voyages.

Mr. Kennedy inquired whether *Mr. Maunder* noticed any difference in brightness between the two borders of the Zodiacal Light. If the light was a ring round the Sun, one part would be further off than the other, and there might be a difference in the illumination.

Mr. Maunder replied that he did not notice any such difference.

Mr. Newbegin exhibited a photograph of a Sun-spot group taken on March 15.

Mr. Maunder said that the spots had been also visible in February as a very fine group, and that it had been associated on its return in March by a very remarkable magnetic disturbance, and the same evening there was a brilliant display of auroræ in many parts.

Mr. Evershed said the spot referred to had shown an unusual activity in the spectroscope, disturbing the C line in an extraordinary manner.

Mr. Schooling read a short paper by *Miss Brown* giving a summary of the sun-spots observed during the half-year ending March 31, 1898, after which the Meeting adjourned.

ROYAL METEOROLOGICAL SOCIETY.

THE Monthly Meeting of this Society was held on Wednesday evening, April 20, at the Institution of Civil Engineers, *Mr. F. C. Bayard, LL.M.*, President, in the Chair.

Major H. E. Rawson, R.E., read a paper on "Anticyclonic Systems and their Movements." Cyclones and anticyclones have long been recognized as powerful weather controls, and their movements studied, but up to the present very little has been written in this country upon the progressive movements of the cores of the permanent high-pressure areas which are found to be associated with certain localities at different times of the year. The author referred to previous investigations by *Abercromby*, *Scott*, *Loomis*, *H. C. Russell*, and *Buchan*, and then proceeded to give the results of an examination which he had made of all the available synoptic weather-charts for the eleven years 1881-1891. During this period there were 212 cases in which the centre or core of an anticyclonic system was over the British Isles, and of these 130 were due to the Atlantic system, 41 to the Scandinavian, and 17 to the Greenland, 22 to the Atlantic and Scandinavian systems extending and merging together, and 2 to the same thing occurring in the case of the Atlantic and Greenland systems. It

is thus evident that we owe the greatest number of our anticyclones to the Atlantic system. They occur in all months, but more especially in January, June, and October, and are least frequent in April and November. When such anticyclones move away from our area the direction is very much influenced by the season of the year. By far the largest number drift off in some direction between north-east through east to south, and take the more southerly course in December, January, and February. Some few between April and July move west or south-west, and still fewer north or north-west.

The Hon. F. A. Rollo Russell described the results of observations which he had made on haze and transparency during 1897. He found that the greatest clearness occurred with winds from the westward, and the least clearness with winds from the eastward. The highest mean visibility was 24 miles with west winds, and the lowest mean visibility was 10.6 miles with north-east winds.

The Recent Solar Eclipse.

DURING the past month there have been frequent public expositions of the results obtained in India on January 22. On March 31, as we stated in our last number, there was a Special Meeting of the Royal Society to hear preliminary statements from the members of the official expeditions. Fellows of the Royal Astronomical Society were invited to be present, and there was a large Meeting, Lord Lister occupying the Chair with Dr. Michael Foster as Secretary. The Astronomer Royal spoke first and showed his series of photographs of the corona, and also the series of the partial phase. Sir Norman Lockyer next described at some length the details of the organization of the crew of H.M.S. 'Melpomene,' exhibited several pictures of the station and *personnel* of the expedition, and then proceeded to show the results obtained with the object-glass prism. He remarked that from the examination of these he was of opinion that there was little, if any, resemblance between the material which formed the chromosphere and the corona. Among the miscellaneous observations during the eclipse he recorded that more stars were seen in the sky during the second partial phases than during totality—which has been before noticed*—and that two of the officers of the 'Melpomene' saw an object between Mars and Venus, which was not shown on the star-charts, and which he hinted might have been a planet.

Dr. Copeland showed his photographs of the corona, and explained that they had suffered considerably by being brought home undeveloped in bass-wood carriers, for the heat had caused fumes which impressed the grain of the wood on the plates. Prof. Turner explained the preliminary results of his polariscope observations

* See Grant's 'History of Physical Astronomy,' p. 373.

The Recent Solar Eclipse.

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by the help of some very lucid diagrams, and Capt. Hills and Mr. Newall's statements brought the Meeting to a close.

On the evening of Tuesday, April 19, the British Astronomical Association held a *conversazione* at Sion College to celebrate the successful return of the Members of the Eclipse Expedition. Mr. N. E. Green, President, received the guests, who numbered more than 300, among whom were the President of the Leeds Astronomical Society, Mr. C. Whitmell, M. E. M. Antoniadi, l'Abbé Moreux of Bourges, Mr. and Mrs. Nevil Maskelyne, Prof. Leahy of Sheffield, besides most of the past and present Officers of the Association. Mr. E. W. Maunder gave an address on the work of the expedition at Talni, and Dr. Isaac Roberts showed his photographs of stars and nebulae and discoursed on the light which they threw on cosmical evolution; a third address was delivered by Rev. J. M. Bacon on the work of the expedition at Buxar. The Bijou Orchestra played at intervals during the evening, and a number of astronomical and microscopical photographs were on view. Sir Howard Grubb exhibited a model of his proposed great floating reflector.

On Thursday, April 21, Mr. E. W. Maunder gave a lecture at the Royal Societies' Club on the recent eclipse. Dr. A. M. W. Downing, F.R.S., occupying the Chair. The lecturer dealt chiefly with two branches of the eclipse work. First, the photography of the corona, illustrated by the photographs taken by the Astronomer Royal, Mrs. Maunder, and Mr. Thwaites; and secondly, the spectrum of the corona and of the lower chromosphere, as illustrated by the work of Mr. Evershed.

The Friday evening discourse at the Royal Institution on April 22 was by the Astronomer Royal, who to a crowded audience explained the circumstances of the eclipse which led to the choice of stations for the observers, and then, so far as was possible with the amount of material, and in the limited time at command displayed the methods of observation and the results obtained by most of the expeditions.

To sum up the outcome of the eclipse, so far as is known at present, although it may be invidious to make selections, it may be well to put on record what we believe to be the general opinion as to who among the English observers take the honours. The series of photographs of the inner corona by the Astronomer Royal are probably the best that have yet been done. We know only of one photograph (excluding drawings made from photographs) which at all approaches the picture with 20 seconds exposure as to delicacy of detail. Mrs. Maunder's photograph of the long streamer creates a record again for the outer corona; as to spectroscopic and other work, it is difficult to assign the true value until accurate examination and measurements have been made, but remembering that it was done single-handed and not by a veteran astronomer, Mr. Evershed's work has undoubted claims to be placed in the front rank of the successes of the eclipse of 1898.

*Some further Notes on the History of the
'Nautical Almanac.'*

[Continued from p. 168.]

SOME notes personal to these gentlemen who formed the staff of the established Nautical Almanac Office may be not without interest. Lieut. W. S. Stratford was 42 years of age when he was made Superintendent; he had entered the navy in 1806 and had seen service in the naval wars at the beginning of the century, but retired on pension in 1815. He was Secretary of the Astronomical Society from 1825 to 1831, the duties of which office he appears to have discharged with much energy, and had taken a large part in the preparation of the Society's Star-catalogue, but no papers especially noteworthy are catalogued under his name. As Superintendent of the Almanac he collected a staff of brilliant young men as computers, chiefly from the north of England, which is mentioned in contrast to the fact that many of the earlier staff lived in Cornwall. W. S. B. Woolhouse, the First Assistant, was a member of a comparatively humble family of North Shields, and when quite a small boy had been known in the town as a mathematical genius. At the age of thirteen he gained a wider reputation by winning a prize for the solution of mathematical problems in the 'Ladies' Diary,' and later contributed largely to the mathematical columns of the 'Newcastle Magazine,' which led to his appointment to the new office at the age of 21. Undoubtedly he was the right man in the right place; the appendices to the Almanacs for 1835, 1836, 1837, and 1839, which were entirely his work, and of which we may specially mention the memoir on the computation of the circumstances of Eclipses and Occultations in 1836, are a series of masterly pieces of work to which it would be difficult to find a parallel. Woolhouse left the 'Nautical Almanac' in the year 1837, owing to a dispute between Stratford and himself* and devoted himself to the problems of life-insurance, and so astronomy lost a valuable mind.

The 'Ladies' Diary' above mentioned was at this period a recognized medium for interchange of ideas by mathematicians. It was the means of bringing to light another member of the staff. Robert Middlemist was also a Northumberland man, and used to answer questions in the 'Diary.' A reader of the publication, a complete stranger to him, introduced his name to Stratford, who offered Middlemist, then 23 years of age, a chair as computer at Somerset House. He does not appear to have occupied it long, for he went as an undergraduate to Christ's College, Cambridge in 1838, was 27th Wrangler in 1842, entered the Church, was after-

* In this connection the following remark of Stratford's biographer may be worth quoting:—"He had strong feelings and was accustomed to confide in their impulses, so that, as may be supposed, his career in the Society and in the world was not without storms."

wards Senior Mathematical Master at Harrow, and died in 1877. Richard Farley, another computer, who joined in 1831, on the other hand, continued in his office for the rest of his working life. He was 20 years of age when he joined, succeeded Woolhouse as First Assistant in 1837, retired in 1869, and died in 1879. His name will be found in the introductions to several well-known works as the responsible calculator: De Morgan's 'Logarithms,' Barlow's 'Tables,' 'The British Association Catalogue,' and the 'R. A. S. Catalogue of Stars.' William Godward at the time of his appointment was a schoolmaster at Wakefield; his brother John afterwards joined him in the office, and later on, in 1847, his son William Godward, Jr., who succeeded Farley as First Assistant in 1869. Of Robert Alger we are not able to trace any particulars. Mr. William Dunkin, one of the members of the earlier staff, had been in his boyhood a school friend of Sir Humphry Davy, and these two lads by their abilities attracted the notice of Davies Gilbert, M.P., a President of the Royal Society, who allowed them the use of his valuable library at Tredrea, his seat near Penzance, and afterwards forwarded young Dunkin's advancement in life by introducing him to Malachy Hitchins. Mr. Dunkin continued his work at Somerset House, but died in 1838. Henry Jenkins, who was also on the staff before 1831, lived at Greenwich, where he worked in immediate conjunction with Pond; his name will be found in the introduction to the Almanac for 1834, and some other years, as the constructor of tables used for the computation of phenomena of Jupiter's satellites. He died shortly after the establishment of the office at Somerset House*.

In the earlier series of these notes Mr. Dunkin stated the origin of the data from which the solar and lunar ephemerides were first computed. Mayer's tables of the Sun continued in use until the year 1804. For the computation of the Almanac of 1805 Delambre's tables, published in the 3rd edition of Lalande's 'Astronomy,' and constructed from Maskelyne's observations of the Sun, were adopted, but were replaced by the solar tables in the 3rd volume of Vince's 'Astronomy' in 1814. Vince's tables, with corrections by Airy, deduced from comparison of Delambre's tables

* Among the earlier computers might have been included the name of Mr. Thomas Henderson, afterwards Director of the Cape of Good Hope Observatory. From the year 1818 Dr. Thomas Young, the Secretary to the Board of Longitude, was also styled "Superintendent of the Nautical Almanac," and he evidently exercised the same functions, possibly with greater freedom of action, than Malachy Hitchins had previously. Thomas Henderson in 1824, then a law clerk in Edinburgh, communicated to Dr. Young a paper on Occultations, which Young thought highly of; and after this introduction Henderson undertook, without remuneration, to help in the computation of the Almanac for several years. When Dr. Young died, he left a memorandum to be given to the Admiralty authorities, which stated that he knew no person more competent to be his successor than Henderson. As we know, this memorandum did not have the effect that was evidently intended. Pond, however, offered work on the Almanac, with a salary, to Henderson, but the latter did not choose to accept this.

with Greenwich observations, were used for the year 1833, and in 1834 Carlini's solar tables were adopted. These, with some occasional modifications, held place up to and including the Almanac of 1863. In 1864 Leverrier's solar tables were introduced, and these hold their place at the present day.

As to the computation of the Moon's place in the Almanac, the lunar tables which were improved from Mayer's by Charles Mason, and based on Bradley's observations, were used until 1804. In the next year the tables in the 3rd edition of Lalande's '*Astronomy*,' which were actually the same as Mason's tables of 1780, except for small alterations in the data, were used. These were exchanged for Burg's in 1813, and these again for Burckhardt's in 1821. The use of Burckhardt's tables was continued until 1862, and in 1863 the Moon's ephemeris was computed according to Hansen, which procedure has only been since modified by the adoption of Newcomb's correction to Hansen's tables, which have been applied in forming the Moon's R.A. and declination since 1884.

The planetary ephemerides from 1767 to 1779 depend upon the tables by Halley. From 1780 to 1804 the tables in the second edition of Lalande's '*Astronomy*' were used, and for 1805, as for the Sun and the Moon, the tables in the 3rd edition of the same work were adopted; those for Mercury, Venus, and Mars having been constructed by Lalande, the Jovian and Saturnian tables by Delambre. The planetary tables in Vince's '*Astronomy*' were used from 1814 to 1833. From 1834 to 1863 the places of Mercury, Venus, and Mars depend on Lindenau's tables, and those of the other three known superior planets on the tables of Bouvard; Prof. Adams's emendation of the tables of Saturn being adopted from 1852. Since 1864 the tables of the planets published by Leverrier in vols. v., vi., xii., and xiv., of the Paris '*Annals*' have been adopted as they appeared. Few changes have taken place in the method of computing the ephemerides of Jupiter's satellites. In the early years of the Almanac the phenomena of the Jovian system depended on data furnished by Wargentin, Secretary of the Royal Society of Stockholm, and, later, on the elements by Delambre, which were emended by Mr. H. Jenkins, the computer whose name is mentioned above. The tables of Baron Damoiseau, still in use, were introduced in the year 1840.

Information as to the precise value of the solar parallax used in the early years is not easily obtainable. In Vince's '*Astronomy*' this fundamental unit is given as $8''.723$; but there is reason for thinking that the value actually used was taken roundly as $9''$ in the early years. Encke's value, deduced from observations of the 1761 and 1769 Transits of Venus, was taken as the measure of the Sun's distance from 1834 to 1869, and this was altered to a value at the other extreme in 1870, when Leverrier's value $8''.95$ was adopted. From 1882 to 1900, $8''.848$, evolved by Prof. Newcomb as the value of the solar parallax, has been used.

Another important factor used in the Almanac, namely the Constant of Aberration, has suffered few changes. $20''\cdot36$ was used from 1836 to 1849, $20''\cdot42$ from 1850 to 1857, and from that date until the end of the century W. Struve's well-known determination $20''\cdot4451$ has been used throughout.

It may be worth mentioning that the daily ephemerides of the planets given for the time of their meridian passage at Greenwich did not originally form a part of the reformed Almanac. These had been computed and published by the Royal Astronomical Society, but owing to the representation by Sir George Airy to the Admiralty that these ephemerides were of particular value, and that it seemed hardly fair that the cost should be borne by the Society, which was not then overburdened with cash, the Admiralty undertook to have them computed as part of the Almanac. They were published as a separate supplement in 1838, and in 1839 formed part of the body of the volume.

In this collection of desultory notes of all kinds it may not be out of place to mention a humorous squib which appeared in the 'Nautical Magazine' for June 1834, and has since been copied into De Morgan's 'Budget of Paradoxes,' purporting to be the report of a meeting of the different bodies of the solar systems, which took place at the Dragon's Tail, for the purpose of taking into consideration the alterations and amendments introduced into the 'New Nautical Almanac.' It was evidently not intended to prove anything, but seems to have been written merely as a facetious effort, and as such we will quote some passages. The Sun was "called to the Focus," and the Focal Body, in his introductory speech, acknowledged the necessity for new solar tables by saying that "he never passed the wires of a transit without deeply feeling his inability to adapt himself to the present state of his theory; a feeling which he was afraid had sometimes caused a slight tremor in his limb." Saturn, in a conservative spirit, objected to the introduction into the ephemeris of "small planets, trumpery comets which could not keep their mean distances, double stars, with graphical approximations, and such obscure riff-raff of the heavens." Pallas, who as a new member was granted a long hearing, on the other hand, "praised the liberality with which he and his colleagues had at length been relieved from astronomical disqualifications. He thought that it was contrary to the spirit of the laws of gravitation to exclude any planet from office on account of the eccentricity or inclination of his orbit." The continuance of this mock quarrel led the Focal Body to interpose with the happy remark that "remarks upon character with a negative sign would introduce differences of too high an order." These few extracts may suffice to give an idea of the nature of a few very laughable pages.

There is little left to tell about the internal history of the 'Nautical Almanac' of the last sixty years. The office must have been moved to Verulam Buildings, Gray's Inn, about the year

1842, for the Almanac for 1846 was issued by Stratford from that address on 1842, Nov. 28. Lieut. Stratford died in 1853, and was succeeded by J. R. Hind, who issued the Almanac for 1857. John Couch Adams was a competitor with Hind for the post, and it is a matter of some wonderment why Adams, with his great mathematical reputation (it was only seven years after the discovery of Neptune), did not get the post; but on consideration it will be seen that the superintendence of the natural ephemeris is work suitable rather for a computer and organiser than a theoretical mathematician. We have been told by an authority who knew the inner history of the matter, that the post actually was given to Hind because he had the responsibility of a large family, whereas Adams had not; but we give this story, which is a little reminiscent of Boz's sketch of the election for beadle, with much reservation.

Of the computers of later years besides those already mentioned, we are able, thanks to Dr. Downing's kind help, to give a list of names, possibly complete. There was a Stoker Woolhouse, who was in the office at the same time as his brother; Edward Russell, who succeeded Robert Alger, and was the first of the staff who gained his appointment by examination; and this reminds us to say that though we have hitherto in these notes spoken of these gentlemen as computers, their official title is now Assistant of the First or Second Class, one being Chief Assistant. Other members of the staff between 1840 and 1850 were J. Hann, John Stevens, R. Bullen (brother of a celebrated official of the British Museum), C. Danford, Samuel Farley (brother of the First Assistant), W. H. Smith, T. P. Cross, Richard Dunkin (second son of Mr. William Dunkin), J. Mansfield, and, later, J. H. Breen (a member of a well-known family of astronomical computers), Thomas Rigby, Arthur Harris, and T. G. Collett. The members of the staff in quite recent years have been given in the introduction to the Almanac since 1896, so there is no need to mention their names here. In the year 1890, when Mr. William Godward retired, Mr. Edward Roberts, who still holds the office, succeeded him as Chief Assistant. Shortly after, in view of the fact that, in accordance with the rules of the Civil Service, the time was at hand for Dr. Hind's retirement, it was felt that there was an opportunity for some additions and improvements in the ephemeris, which were demanded by the advance of the science. Consequently a committee of the Royal Astronomical Society was formed to discuss the matter, and when at the end of 1891 Dr. Hind was released from his office, Mr. (now Dr. and F.R.S.) A. M. W. Downing, a First Class Assistant at Greenwich, and a Secretary of the Royal Astronomical Society, who had contributed largely to its proceedings, was recommended as his successor. Under his directions the wishes of the Committee have been ably carried out, and the '*Nautical Almanac*' stands in no danger of falling behind the times under his energetic rule.

H. P. HOLLIS.

CORRESPONDENCE.

*To the Editors of 'The Observatory.'**Dark Elliptical Spots in the North Tropical Zone of Jupiter.*

GENTLEMEN,—

Herr Brenner, in your issue for March, p. 132, refers to two dark elliptical spots situated just north of the northern equatorial belt of Jupiter and in lat. $+15^{\circ}$. These spots have been observed by Herr Fauth (Ast. Nach. 3488) and many others during the present apparition of the planet. A few of the observations are as follows:—

		Spot B. λ.	Spot C. λ.	Observer.
1897	Nov. 25	305°	360°	Fauth.
	Dec. 15 ....	....	352°	"
	22 ....	....	347°5	"
	22-26..	298°3	....	"
	31	296°5	338°5	"
1898	Jan. 7-14..	294	....	"
	19	293	329	Brenner.
	Feb. 10	281	....	Fauth.
	Mar. 14 ....	....	309°9	Denning.
	21	266°1	311°1	Phillips.
	28	262°8	....	"
	April 5 ....	....	306°8	Denning.
	5 ....	....	306°2	Phillips.
	7 ....	....	303°1	Denning.
	12	259°5	303°6	Phillips.
	17	254°3	301°5	"
	17	254°3	298°4	Denning.

There is a third spot, which we will call A, of similar kind, referred to by Brenner in Ast. Nach. 3476, and its position has been recorded as under:—

		Spot A. λ.	Observer.
1898	Jan. 20	144°5	Brenner.
	23	145°0	"
	Mar. 5	131°4	Williams.
	13	131°6	Phillips.
	20	129°9	"
	23	126°7	Denning.
	April 1	125°1	Phillips.
	4	123°7	Denning.
	6	123°2	Phillips.
	16	120°1	Denning.
	16	118°9	Phillips.
	18	120°3	"
	18	120°7	Denning.

It is evident that the three spots have been moving at very different rates, as the following comparative summary shows :—

Spot.	Period of observation. d	Drift to West. °	Daily rate. °	Approx. period of rotation. h m s
A	88	23·8	0·27	9 55 29·5
B	143	50·7	0·35	9 55 26·0
C	143	60·0	0·42	9 55 23·4

The spot C appears, therefore, to have exhibited a period no less than six seconds less than that of A. The three spots are moving much faster than the garnet- and violin-spots of 1895-96, and the white and dark spots visible in the same latitude in 1894-95. The longitudes are computed with reference to the zero meridian, system II., of Mr. Crommelin's ephemerides ('Monthly Notices,' Jan. 1898). When the observations have much further progressed it will be interesting to investigate the relative motion of the three spots in a more thorough manner.

The observations, above quoted, by the Rev. T. E. R. Phillips, of Yeovil, were made with a 9-inch With mirror, those at Bristol were obtained with a 10-inch With mirror and power 312.

Yours faithfully,

Bristol, 1898, April 20.

W. F. DENNING.

Eclipses mentioned in the Anglo-Saxon Chronicle.

GENTLEMEN,—

I must apologize for writing again upon the above subject, having done so before in No. 188 (vol. xv. p. 224) of your valuable journal, in which I have already taken up too much space. But I was led, in consequence of some discussions which have lately appeared in the press respecting the exact date of the death of King Ælfred, *à propos* of his approaching millenary, to consult once more the records of eclipses in the Anglo-Saxon Chronicle, with the view of ascertaining, if possible, by the aid of astronomy, the degree of accuracy of the dates therein. In doing so I need hardly say I have followed Thorpe's edition of the original texts (published in 1861); a comparison with Ingram's version of 1823 showed various errors in the latter which it is scarcely worth while to mention severally, though I may be permitted to point out (particularly as I inadvertently followed it in my former letter) that in that version an eclipse of the Moon is stated to have occurred on the seventeenth day before the calends of August in the year A.D. 807, whereas the Cottonian Manuscript, Domitian A. VIII., as printed by Thorpe, gives this as the year A.D. 809, in which an eclipse (annular in some places) did occur on the 16th of July, agreeing with the record in the Chronicle. Ingram's version speaks of an eclipse of the Moon on the thirteenth day before the calends of January A.D. 802, and two of the manuscripts really state this; no such eclipse, however,

occurred at that time, and Mr. Johnson thinks that the lunar eclipse of May 21 was the one referred to (*January* being perhaps written by mistake for *June*), as this was nearly total in the early morning, and the Chronicle states that it occurred "at dawn." A mistake somewhat similar is mentioned in my former letter as fallen into by the Chronicler about seven years before, stating that an eclipse of the Moon occurred on the fifth day before the calends of April in the year A.D. 795; one did take place on the 9th of April, or the fifth day before the *ides* instead of the *calends* of that month.

These explanations seem very satisfactory, and I need not again allude to the error mentioned in the last paragraph of my former letter respecting a solar eclipse of much later date. All the others recorded in the Chronicle did really occur on the dates therein mentioned, with two exceptions. To one of these I have called attention in my little book on 'Remarkable Eclipses': it is the case of an eclipse of the Sun said to have taken place in the year A.D. 879, no day mentioned, but stated to have been "one hour of the day." No such eclipse occurred that year, but the circumstances would agree with one which was total over part of Europe, and greatest in England soon after noon on October 29 the year before, or A.D. 878, the year (according to the Chronicle) of Ælfred's great victory over the Danes in Wiltshire, which was followed by the treaty of Chippenham (or Wedmore). Thorpe, however, thinks that the error respecting the solar eclipse under date 879 in the Chronicle was really a year the other way, and was that of March 14, A.D. 880, which was annular farther south, and occurred a little before sunset in Western Europe; and this because Florence of Worcester states (whatever were the sources of his information) that its time was between nones and vespers, but nearer nones. This point, then, seems to be doubtful; but the other eclipse (a lunar one, mentioned in my former letter) is certainly dated in the Chronicle one year too early. For it is there said to have taken place on Christmas Day ("mid-winter's mass-night") A.D. 827; and a very large, not total, lunar eclipse did really occur on December 25, A.D. 828.

Many eclipses are mentioned in the Chronicle, and of all, except these, the dates are given correctly; so that on the whole this examination is in favour of the accuracy of its chronology. It gives the date of Ælfred's death, A.D. 901, October 26.

Yours faithfully,

W. T. LYNN.

Blackheath, 1898, April 7.

Variation of Personal Equation with Magnitude.

GENTLEMEN,—

Will you permit me to communicate to you a note on the variation of personal equation with stellar magnitude? In No. 48 of the 'Astronomical Journal' that eminent astronomer, Dr. G. W. Hill, in criticism of Prof. Newcomb, says:—"With regard to the

variation of personal equation with stellar magnitude, all we know of physiological optics would incline us to suppose that the great part of this variation lies between the fifth and sixth magnitudes and not between the latter and the last which is visible."

To this view of Dr. Hill's I have two objections. The first is that the question is one of physiological psychology, and not of physiological optics alone. The optical part of the experience is relatively small, and the main part a matter of psychology. My other objection to Dr. Hill's statement is simply that the observed facts do not appear to me to be in accord with it. Argelander distinctly expresses the opinion that his own personal equation changed for very faint stars $9^m.5-9^m.6$ on the B.D. scale, and that the amount of this change was $0^s.2$ or $0^s.3$ under such circumstances. Auwers also has expressed the opinion that this variation was even larger in Argelander's case. The various experiments with screens which have been tried in the process of controlling the accuracy of the *Astronomische Gesellschaft's* Catalogue have invariably, as far as I know, dealt with observations of faint stars, and I cannot find among my books any attempt even to determine the variation of personal equation between the first and sixth magnitudes. For a number of the zones of the A. G. C., which were chronographically registered, the *Helligkeitsgleichung* has been determined with reference to the faint stars from the 7th to the 9th magnitudes and fainter, and found sensible for the fainter magnitudes. For the eye-and-ear zones little has yet been done in this direction. The result of that little has been in general that the variation with magnitude is of trifling importance, except, as in Argelander's case, when the star is very faint. In that case the "displacement of time" can be reversed in sign, and the faint star observed too soon by eye and ear. By chronographic registration the faint star is observed too late according to the general experience of astronomers. The delay in registration due to the faintness increases as we approach the limits of visibility.

Were Dr. Hill's statements in accordance with the observed facts, the history of meridian observations would become so perplexed a matter that at least another century would be required to disentangle it. Fortunately, however, the positions of stars visible to the naked eye have been but slightly affected by the variations of personal equation with magnitude in the eye-and-ear observations of Bradley, Bessel, and their successors until chronographic registration came into vogue in the middle of this century.

The subject of personal equation and its variations is so difficult at best that experienced observers and computers are often at a loss how to deal with it, and I trust I may be pardoned for suggesting that Dr. Hill's statement quoted above is the result of an oversight.

I remain, Gentlemen,

Yours faithfully,

Williamstown, Mass.,
March 21st, 1898.

TRUMAN HENRY SAFFORD.

PUBLICATIONS.

A CATALOGUE OF THE MAGNITUDES OF 1081 STARS LYING BETWEEN -30° DECL. AND THE SOUTH POLE (1885-6), BY A. STANLEY WILLIAMS *.—This is a remarkable piece of evidence, were any needed, as to the valuable work that can be done by an astronomer endowed with genuine enthusiasm under conditions the reverse of ideal, and with an equipment for which the word meagre seems almost flattering. In the years 1885-6 Mr. Williams made a voyage round the Cape of Good Hope to Australia, and after staying on that continent two months returned *viâ* the Red Sea. He took the opportunity to make a series of observations of the brightness of stars in the southern hemisphere, which he now publishes in the form of a catalogue as above described.

Mr. Williams's results, obtained principally with an opera-glass while on board ship, show a good accordance with Bailey's 'Southern Meridian Photometry' and the 'Uranometria Argentina,' remembering that the magnitude-scale of these two catalogues is somewhat different; his observations which do not agree with these authorities are to a great extent to be explained by proved or suspected variability, or accounted for by the peculiar atmospheric irregularities of the Southern Ocean. One of these stars which show discordance, *V Puppis*, has taken its place among the variables, and thirteen others promise to do so in the future.

ROUSDON OBSERVATIONS.—In our number for last January we recorded the appearance of the first (numbered 2) of a series of pamphlets containing Mr. Cuthbert Peek's observations of variable stars. We have recently received number 3 of the series, which gives, in a manner similar to the previous publication, the observations of *S Cassiopeiæ* and *S Ursæ Majoris* made in the years 1887-1896.

OBSERVATORY OF CATANIA.—We have received from the Director, M. Ricco, a publication containing the history and construction of this Observatory at Mt. Etna. We gather that the Observatory is well furnished. There is a 13.4 inch refractor by Merz, a standard astrographic 13-inch, and a 6-inch Cooke, and a Reichenbach Transit. The accompanying photographs exhibit the domes and instruments. 226 catalogue plates, 46 chart plates have been taken and 518 stars measured. In addition, photographs of the following have been taken: 33 clusters, 21 nebulae, 3 comets, and 41 lunar. As the building was only begun in 1897, a large proportion of the time since has been devoted to mounting and adjusting the several instruments. A large amount of meteorological work is also done.

DR. SEE'S WORK ON DOUBLE STARS.—In the 'Astronomical

* London: Taylor and Francis, 1898.

Journal,' Nos. 431-432, Dr. See publishes his "Discoveries and Measures of Double and Multiple Stars in the Southern Hemisphere." Mr. Lowell placed the 24-inch refractor of his Observatory at Dr. See's disposal that he might survey the southern heavens for the discovery of new double stars and nebulae, and it will be seen, in reading his paper, that full use has been made of this fine instrument. It was to be expected that some of the stars observed as "new" were afterwards recognized as known pairs. These are included in the list with a note. A power of 500 was generally found suitable for the instrument, but 750, 1000, and 1500 have been used. Careful notes were made of the colours and magnitudes, so that full information is given to enable other observers to identify the pairs. The list contains 500 pairs, many of which will no doubt prove most interesting. Dr. See is to be warmly congratulated on this, his first catalogue.

NOTES.

COMET NOTES.—Perrine's Comet (*b* 1898) has been a very conspicuous object during April, having a nucleus of about the seventh magnitude, and a tail at least half a degree in length. The following elements have been deduced by Prof. Kreutz from observations on March 19, 23, 27, 31, and represent very closely the place of the comet on April 15 (Ast. Nach. 3486):—

T	1898 March 17	3756 Berlin M.T.
ω	47° 34' 12"	} 1898.0.
δ	262 34 0	
i	72 27 48	
log q . .	0.04084	

Ast. Nach. 3488 contains an ephemeris of the comet (for Berlin midnight) computed from the above elements:—

	R.A.			N. Dec.		R.A.			N. Dec.
	h	m	s			h	m	s	
May 3	0	47	49	51° 35'	May 27	2	50	48	56° 11'
7	1	9	35	52 57	31	3	8	32	56 19
11	1	31	6	54 2	June 4	3	25	17	56 21
15	1	52	8	54 52	8	3	41	3	56 17
19	2	12	32	55 29	12	3	55	50	56 10
23	2	32	6	55 55					

Brightness 0.5 on May 2, 0.2 on June 5.

Ast. Nach. 3481 contains the following elements and ephemeris of Wolf's Periodic Comet by A. Thraen, based on the observations made at the last two returns with the application of perturbations by the Earth, Mars, Jupiter, Saturn:—

Epoch and Osculation 1898 Aug. 22^o Berlin M.T.

M.....	6° 58' 11"	} 1900 ^o 0.
π	19 21 38	
δ	206 29 4	
i	25 12 16	
ϕ	33 44 2	
μ	518".368	
log α	0.556912	

Perihelion passage 1898 July 4^d.56 Berlin M.T.

Ephemeris for Berlin Midnight.

R.A.			N. Dec.	R.A.			N. Dec.
h m s			° ' "	h m s			° ' "
June 3....	1 36 19		18 33	Aug. 10....	4 52 59		16 49
11....	1 59 58		19 19	14....	5 3 13		16 6
19....	2 23 48		19 51	18....	5 13 12		15 20
27....	2 47 43		20 9	22....	5 22 52		14 29
July 1....	2 59 39		20 11	26....	5 32 13		13 36
5....	3 11 32		20 10	30....	5 41 13		12 39
9....	3 23 22		20 5	Sept. 3....	5 49 52		11 40
13....	3 35 7		19 55	7....	5 58 12		10 37
17....	3 46 44		19 41	11....	6 6 7		9 32
21....	3 58 15		19 23	15....	6 13 38		8 24
25....	4 9 35		19 0	19....	6 20 45		7 14
29....	4 20 45		18 33	23....	6 27 26		6 2
Aug. 2....	4 31 43		18 3	27....	6 33 41		4 48
6....	4 42 28		17 27	Oct. 1....	6 39 28		3 33

The brightness is 1.7 on June 3, and rises slowly and steadily to 2.7 (the maximum) at the end of October. The unit is the brightness on May 1, 1891.

On July 19 the comet makes a close approach to Mars, as the following table (for Berlin midnight) shows:—

Mars.				Comet.			
R.A.		N. Dec.	log Δ .	R.A.		N. Dec.	log Δ .
h m s		° ' "		h m s		° ' "	
July 18...	3 51 32	19 30	0.2325	3 49 37	19 36	0.2841	
19...	3 54 23	19 39	0.2313	3 52 30	19 32	0.2828	
20...	3 57 15	19 49	0.2302	3 55 22	19 27	0.2816	

The least angular distance is thus 27', and the least actual distance between the bodies some 19 millions of miles.

'Bulletin Astronomique' for April contains an investigation of the orbit of Comet 1871 IV. (Tempel) by M. Lagarde.

This comet was discovered on Nov. 3, 1871, and was observed in the northern hemisphere till Nov. 18, when it was lost in the sunshine. It was recovered at Cordoba on Jan. 17, and numerous observations were obtained there and at the Cape up to Feb. 20.

The comet passed within 6° of the South Pole, which considerably added to the labour of the computation. Six normal places were formed, viz., two each in November, January, February. Perturbations were applied for all the planets for which they were sensible. He deduces the following elliptical elements :—

T	1871 Dec. 20	40943	Berlin M.T.	
ω	242°	53'	9"	} 1870.0.
Ω	147	6	45	
i	98	18	51	
log q		9.839646		
e		0.99573		
Period.	2030 years.			

He concludes that the period in all probability lies between the extremes 1880 and 2179 years. A. C. D. C.

THE CONSTANT OF PRECESSION.—The discussion between Prof. Newcomb, Prof. Boss, and others on the most recent determination of the constant of precession and its adoption by astronomers, which we have been following up lately, has been brought to a close in the last received number of the 'Astronomical Journal' (No. 433), where Prof. Newcomb says his last word, and Prof. Boss agrees with him that the time has come to close the matter. As to the ethics of the adoption of new values of the constant in the National ephemerides, Prof. Turner has made some cogent remarks in his note on page 218. The American astronomers deal more especially with the astronomical side of the subject. Prof. Newcomb implies that even if he had used much of the material that he is accused of having omitted, there would then probably have been more room for criticism. In 50 years' time there will be an accumulation of much more material, and there will be no greater "emergency" then than there is now for adopting a new value of the precession constant; but the task of the investigator will be ever so much harder, almost impossible, and then "the investigator must therefore select the best on which to base his conclusions, and then there will be no limit to the rhetorical force with which the objector can describe the value of the omitted material, and the magnitude of the mistake made in leaving it out." This seems equivalent to saying that no one man is able to satisfy everybody; and this is the keynote of Boss's reply, for he criticizes further the astronomy of Newcomb's work, but says he would not have written a word in criticism, only he was obliged, because it was proposed to hall-mark this work of one man as worthy of general assent and adoption. Prof. Boss concludes the discussion thus: "I hope the time and energy employed in this discussion have not been wholly wasted. They will not have been wasted should they stimulate meridian-observers in the smallest degree (and

especially the observers at our antipodes) to exercise greater skill, judgment, and diligence in supplying the obvious deficiencies of our knowledge in sidereal astronomy."

U PEGASI.—In our March number (p. 129) we mentioned that Dr. Chandler was not prepared to admit that Mr. Wendell's observations of the variable U Pegasi showed conclusively that the brightness of this star was different at alternate minima, which if true led to the deduction that the star had a light curve resembling that of β Lyræ, that its period of light-variation is very nearly 9 hours, and that it has a secondary minimum about midway between two primary minima, when its brightness is 0.15 of a magnitude greater than at primary minimum. All depends on the weight that can be given to Mr. Wendell's observations. Prof. Pickering replies to Dr. Chandler in Harvard Circular No. 25, in which, after describing different forms of photometers, including the one with which the observations of U Pegasi were made, he gives the individual results of these observations. Twelve observations, each the mean of 16 settings, made at the time which we may call primary minimum, range between 9.85 and 9.96. Fourteen observations, taken within 20 minutes of the times of so-called secondary minima, range between 9.69 and 9.80. Then, says Prof. Pickering, if the brightness of the star is the *same at all* their minimum epochs, and these differences are accidental error, it is remarkable that all the large values should occur at even minima and all the small ones at odd. There is only one of the fourteen large values which could possibly be included in the set of fainter values, so that if this is accidental the chance that it should have happened thus is the same as that a person should draw a red card from a pack twelve times in succession, and then should draw a black card thirteen times out of fourteen.

THE HEIGHT OF METEORS.—Mr. Denning has contributed to a recent number of 'Nature' (April 7) an article on this subject. The distance from the Earth at which meteors are generally seen has been variously estimated. Schröter, in 1795, gave the height of a meteor which he saw as four million miles. Brandes, from a series of observations in 1823, deduced the average height as between 30 and 70 miles. Wartman, of Geneva, in 1838, derived an average height of 550 miles. Brandes's determination did not widely differ from the generally accepted value, for authorities now agree that the average heights at appearance and disappearance are about 76 and 51 miles respectively. In the present paper Mr. Denning especially discusses the greatest distances from the Earth at which meteors are seen. The class of meteors called fireballs penetrate much deeper into our atmosphere than the ordinary shooting-stars, their point of extinction being about

30 miles high; and Mr. Denning points out that they also have a greater height at the beginning of their visible path, so that if their combustion is caused by atmospheric friction our atmosphere extends to a greater distance from the Earth than is generally supposed.

It appears that 20 per cent. of meteors, including a large proportion of fireballs, are at least 100 miles high at the instant of their first visible apparition. Mr. Denning believes that the actual height at first appearance of a meteor is *very rarely* as much as 150 miles, and that it seldom reaches beyond 130 miles. He gives a list of 10 meteors whose height at beginning has been computed as a little over 180 miles, which are extreme cases, and are embraced in ten years of observation, and many of these may be too large owing to imperfect observation; for an observer very seldom catches the exact position of a meteor at beginning of its flight, but noting it a short time after it has started mentally carries its path backward through a distance which he probably estimates too large.

THE STANDARD TIME OF FRANCE.—On February 24 last the French Chamber of Deputies passed, without discussion and on show of hands, a Bill entitled "Modification of the French Legal Time to put it in agreement with the Universal Time System." The sole clause of the Bill (we learn from our Belgian contemporary 'Ciel et Terre') reads: "The Legal Time in France and Algeria is the time which is 9^m 21^s slow on Paris Mean Time." It will be seen that the effect of this is to make Greenwich Time the standard for France. The reasons given for the introduction of the Bill are contained in the following words: "We are not able, without damaging our economic interests, to remain in an isolation which nothing can any longer justify. The reform will be effected without substituting the English meridian for the meridian of France, which is, and ought to remain, our national meridian." The Bill has still to receive the approval of the Senate before it becomes law, and meanwhile the Bureau des Longitudes is taking steps to oppose it.

DETERMINATION OF THE SOLAR ROTATION FROM FACULÆ.—M. Stratonoff has made an exhaustive examination of faculæ shown on the photographs of the Sun, taken at Poulkova in the years 1891, '2, '3, '4, with the view of determining whether they give indications of variation in the rotation-period depending on latitude. The great difficulty in such a research is the identification of the groups of faculæ on successive days. They change so quickly in appearance that it is almost impossible, in the great majority of instances, to be at all certain of the identification. This is well shown by the following table, where the second column shows the

number of plates studied, and the third the number which could be used. Even after this the measures were still subjected to certain criteria before M. Stratonoff could feel justified in using them.

Year.	No. of plates examined.	No. of plates used.
1891	86	60
1892	112	57
1893	118	76
1894	84	41
Sum	400	234

The faculæ finally accepted are arranged in order of date, with full particulars of measures and identifications, so that the material can be verified. The result obtained is:—

Lat.	Rotation in 24 hours.		Means.
	North. Hem.	South. Hem.	
0° 0'	0°	0°	0°
0-4	14°62	....	14°62
5-9	14°61	14°63	14°61
10-14	14°34	14°26	14°31
15-19	14°14	14°21	14°18
20-24	14°21	14°17	14°19
25-29	13°97	14°20	14°08
30-34	13°50	13°65	13°60
35-40 .....	....	13°61	13°61

FROM the publication of the O'Gyalla Astrophysical and Meteorological Observatory, we learn that Dr. Konkoly has pursued the programme of observations of sun-spots laid down some years since. The present volume contains the results for the years 1894 and 1895, from which we extract the following:—

Year.	Days of observation.	Spot groups.	Faculæ.	Nett No.
1894	145	595	1857	53·7
1895	133	485	1785	51·4

Each group is separately described, and the approximate position of the spots given in a table.

There is also a table showing the meteors observed systematically at O'Gyalla, Budapest, and Pressburg. Observations of Comet 1894 II.

THE DATE OF EASTER.—The following paragraph is from the 'Daily News' of April 9:—

"The coming of Easter has revived in Berlin the discussion of

the question whether it would not be a good thing to limit the movableness of the festival. A year ago (says our Correspondent) this matter occupied, not only the Press here, but also men of science, such as Professor Förster, Director of the Berlin Observatory, who, in an article, pointed out the important task the Pope might accomplish by taking in hand the settlement of this question. Professor Förster also communicated with Signor Tondini, and with the astronomers of the Vatican Observatory. Their common proposal was to fix Easter from the year 1900 on the third Sunday after the equinox, that is to say, after the 21st of March, the Moon no longer influencing the date. The festival would then only vary between the 4th and the 11th of April, instead of between the 22nd of March and the 25th of April as now.

THE DIRECTORSHIP OF THE LICK OBSERVATORY.—Prof. Keeler does not seem altogether eager to accept the post vacated by Prof. Holden. He is at present, as may be remembered, Director of the Allegheny Observatory, Pennsylvania, and he has intimated to the Observatory Committee that they may retain his services by providing within two weeks a sum of 200,000 dollars for the erection of an observatory with a 30-inch telescope at Allegheny, and for the endowment of a chair of Astronomy in the Pennsylvania University. It is reported that Prof. Keeler is so much appreciated that the citizens of Allegheny city are liberally subscribing towards this sum*.

AN absurd paragraph has been going the rounds of the less circumspect papers, which states that a certain officer of the Austro-Hungarian army "believes he has solved the problem of bringing the stars within a few hundred yards of the Earth." We need scarcely add that this is to be done by a gigantic telescope. One morning paper gave a picture (drawn, of course, from imagination) which showed a huge concave mirror, like a basin 50 yards in diameter, balanced *outside* the top of the dome of the observatory.

WE have received a copy of the 'Sydney Mail' of Feb. 26, a page of which is devoted to our occasional contributor, Mr. John Tebbutt. We are glad to see from the portrait, which with pictures of his observatory accompanies the sketch of his life and work, what manner of man this energetic gentleman is.

A CORRESPONDENT kindly calls our attention to a close conjunction of Ceres and Pollux which will take place on the evening of May 20, and is not mentioned in the usual ephemerides. Ceres will be 6' north of the star. Also to a conjunction, but not such a close one, of Ceres with Castor on May 14.

* Since the above was written we have heard that Prof. Keeler has definitely accepted the directorship of the Lick Observatory.

WE call attention to the occultation of Venus by the Moon, predicted to take place on the evening of May 22. The circumstances will be found in the 'Companion.'

THE Royal Astronomical Society has lost two of its oldest Fellows. The death is announced of Dr. Alfred Wrigley, who was elected a Fellow on 1842, March 11; and also of Mr. John Hippisley, F.R.S., who died at Bath, aged 93, in April. Mr. Hippisley was elected a Fellow of the Astronomical Society 1849 Dec. 14.

WE have heard also of the death of Prof. W. A. Rogers, a member of the staff of Harvard College Observatory. The meridian work of that institution was mainly in his charge.

VISITATION DAY at Greenwich this year will be on June 4. The dinner, as in recent years, will be held at the Criterion Restaurant, Piccadilly Circus.

Mr. CHARLES CHREE, Superintendent of Kew Observatory, has received the honorary degree of LL.D. from the University of Aberdeen.

FROM AN OXFORD NOTE-BOOK.

LAST night's evening papers contained the news that the American mail-steamer 'Paris' had been captured by a Spanish torpedo-boat. The news is of the evening-paper kind and subject revision; but assuming for the moment that it is true, I wonder whether the Captain of the 'Paris' threw his chronometers overboard on lowering his colours? I am credibly informed that the following device is, or has been, in existence for encouraging the study of lunar distances by the youthful naval officer, who finds the study distasteful owing to the complexity of the calculations and the apparent uselessness of the method (now that we have good chronometers). The instructor points out that, although in times of peace, when chronometers are plenty, lunar distances are at a heavy discount, yet in times of war, "when you take a prize" (perhaps a delicate emphasis may be laid on the "you") "the captain of the magnificent vessel which surrenders will probably throw his chronometers overboard, and then you will be puzzled how to navigate the prize safely into port. Of course there will probably be three chronometers on your own ship; and if it is the first occasion of her taking a prize, it may be that one of these can be spared for the officer put in charge. But what is to happen in the case of the second and third &c. prizes? They will have to be navigated home by lunar distances; and hence we will continue the study of this most important matter." There is considerable wiliness in this argument, and owing to the scarcity of naval engagements in recent years it has not been possible to rebut it by reference to actual facts. But now that war has been declared, we are bound to have further light thrown on the subject,

and I for one shall await with interest the accounts of the prize-navigations, of which it seems possible we may have a series. Will the first idea of the surrenderers be still to harass their captors, or will their desire to get safely into port, even in the hands of the enemy, be paramount? For after all to throw over-board the chronometers of a ship you are to travel in, though a prisoner, is rather like "cutting off your nose to spite your face."

SHOULD the events of the forthcoming war knock the bottom out of this argument for learning the method of lunars, it will bring us appreciably nearer the time when we may expect the tables of lunar distances to disappear from our Nautical Almanacs. There are many who think they might go even now, without assuming that the method of lunars is quite obsolete; for the cases in which it will be used are sure to be rare and exceptional, and on such occasions the theoretical distances (required for comparison with the observed) could be calculated from other data given in the N. A. without serious additional labour. A few detailed directions for the computation might thus take the place of the present elaborate tables. However, it is just as well, perhaps, not to make such an important change in our Nautical Almanacs too hastily: certain things have been said lately on the subject of hasty changes in these volumes which will no doubt have their effect in restraining undue haste in the future. If lunars might possibly on an exceptional occasion save a big ship, they are well worth retaining for a century or two on the off-chance; and it is for sailors, not astronomers, to say when this chance becomes absolutely zero.

CONCERNING the other changes hinted at in the last paragraph, I should perhaps add a word in justification of the epithet "hasty." I am referring, of course, to the changes proposed at the Conference of Superintendents of Ephemerides held in Paris in 1896, adopted in the American Ephemeris for 1900, and in our own N. A. for 1901. The Superintendents no doubt spent considerable time and trouble in arriving at their decisions; their haste was not in the actual discussion, but in assuming that this discussion among themselves was sufficient to secure the approbation of astronomers generally for their decisions. How curiously mistaken they were in this assumption is shown by the fact that not only have the decisions been severely criticized by men like G. W. Hill, Lewis Boss, Asaph Hall, Chandler, and others, but (so far as I know) not a single word of unqualified commendation of the changes has been published by anyone who was not actually present at the Conference. Of course the Superintendents may be right and the others wrong; it may be that we shall benefit by these changes;

but to do people good in spite of themselves and then to convince them of the fact is no mean undertaking, and though we may admire the courage of the associated Superintendents in attempting it, we cannot but feel a little anxious as to the result.

THE articles of Mr. Dunkin and Mr. Hollis on the past history of our 'Nautical Almanac' are very interesting to me, and I hope the Editors may be able to give us some slight history of the other national ephemerides for comparison in the near future. Among the possible and impossible uses of an "end of the century," that of making it an opportunity for historical review is perhaps one of the most legitimate. I was particularly glad to see prominently mentioned in Mr. Hollis's article last month the fact that the present form of our 'Nautical Almanac' is in great measure due to the Royal Astronomical Society, who were in 1830 honoured by a request from the Admiralty to take the matter into consideration, and appointed a strong Committee for the purpose (see Preface to N. A. for 1834, and 'Observatory,' No. 265, p. 167). It may not be generally known that the Admiralty has quite recently again done the Society the honour of inviting its opinion on the changes introduced into the N. A. for 1901, and a Committee has the matter under consideration, their deliberations being temporarily suspended until certain promised information is supplied to them.

ACCORDING to a Mauritius paper, there was a serious omission in the N. A. for 1897. We find therein predictions of two eclipses and two only; and, as we learn in the text-books, these were accordingly both of the Sun. But a correspondent has kindly sent me the following cutting from the Mauritius 'Merchants' and Commercial Gazette' for 1897 November 11:—

ECLIPSE ET TREMBLEMENT DE TERRE À TAMATAVE.

Dans la soirée de mercredi 27 (Octobre), vers huit heures moins un quart, il y a eu une belle éclipse de lune à Tamatave. L'astre des nuits s'est évanoui peu à peu dans un ciel sans nuage, pour reparaitre seulement 40 minutes après. Une lettre particulière nous apprend qu'un tremblement de terre a secoué la ville de Tamatave pendant 3 secondes, dans la nuit du 3 au 4 novembre.

The odd thing is that the Moon was new on October 25, so that Tamatave must have a creditable climate to have seen the Moon at all, let alone see it eclipsed. Those of us who have been to India lately, and seen the one-day-old Moon set right to the tips of the horns with the Earth-shine remaining visible above the horizon, are prepared to expect exceptional achievements from a two-day-old Moon, but an eclipse is a little trying even to our imaginations.

THE following communications have reached me through the Editors. They were both addressed to the "Owner of the Oxford

Note-Book " at a time when he was away, and my correspondents will please accept this explanation of the delay in making use of their communications, which was not due to any lack of appreciation :—

Yesterday a lieutenant of the Austrian army asked me quite seriously whether it should not be possible to reach *Mers* with a giant balloon !!! A *lieutenant-field-marshal* present objected only that our *technical means* would not yet suffice to give the necessary size to the balloon !!!!

Having noticed that the humours of Astronomy are always welcomed by you in your amusing Note-Book, the following incident may interest you.

At a well-known seaside resort I was one evening watching the people as they took "penny peeps" at Jupiter through a 3-inch telescope. A lady, who seemed to find the matter very interesting, by the length of time she took gazing through the tube, noticed that even when she did not push the telescope on one side with her nose, that Jupiter vanished out of the field of vision very quickly ; so she asked a gentleman friend standing near at about what rate Jupiter moved. "Oh," he replied in an off-hand manner, " at about 250 miles an hour !"

At the end of last month's notes I quoted a passage of a denunciatory kind, showing how a literary man regards science in his severer moods. Here is an engineer's complaint against mathematicians. I make no attempt to comment on such things ; one might write volumes in reply or in support without seriously affecting the situation. The complaint is not a new one ; it has been made often before, and it is not easy to see how its recurrence in the future is to be obviated ; meanwhile it does not do any harm to be reminded of it occasionally. The extract is from a paper in the Proc. Amer. Acad. of Arts and Sci., entitled "Suggestions for the Developments of the Arts and Sciences," by W. R. Livermore, Major of Engineers, U.S. Army, and on page 36 we find the following deposition :—

I had occasion once to look into a question of mathematical physics that was not so elementary as to be found in an engineer's pocket-book ; and so I consulted a treatise on the special branch in which I was working. From the index and table of contents I had no trouble in finding the place, but did not know what the letters stood for. I read the chapter through without learning, and then read the chapter before it. There were the same signs, and I was referred back to chapter after chapter, then to another book on general physics, which I read half through, and then to a book on mathematics, with no better result. Then I took up one of the books on physics again and began at the Preface. I found nothing about the signs, but much about the Cambridge Tripos. I had not been connected with any university for several years, and I thought a Tripos was a thing to set a theodolite on. I looked in the dictionary, and found that it was a writer of Latin verses on the back of a slip of paper containing the names of bachelors who were highest in the list. That explained everything. The Latin verses were the end and motive of the whole system. The books were not meant to be understood by anybody who did not go through the whole mill. In the innocence of my heart I wanted to find out something about fog-signals to save the lives of seamen, and I had been referred to the little Latin verses for boys. I then worked out the problem of general principles in less than a tenth of the time I had spent in looking it up.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

JUNE, 1898.

No. 267.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, May 13, 1898.

Sir R. S. BALL, LL.D., F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. TURNER, M.A., B.Sc., F.R.S., and
H. F. NEWALL, M.A.

THE Minutes of the previous Meeting were read and confirmed.
Mr. Newall. Since the last Meeting 75 presents have been received by the Society. There are two or three of these to which I should like to call attention. We have received from the Observatory two photographs of the solar corona of 1898, January 22, taken by the Lick Observatory expedition. From Harvard College Observatory we have received, in the usual course, Circular No. 28, which is especially interesting as it gives an account of a photographic observation of the spectrum of the aurora, which is, I believe, the first observation of this kind. We have also received from Mr. T. R. Dallmeyer a valuable little book written by him, entitled 'A Simple Guide to the choice of a Photographic Lens.'

Dr. Isaac Roberts read a paper, and illustrated it with lantern slides projected on the screen, on Nebulæ in the Pleiades, of Stars in the surrounding Regions, and of Spurious Nebulosity.

The photographs had been taken with the 20-inch reflector and with the 5-inch Cooke lens, the plates being exposed simultaneously in the two instruments with respective exposures of 8^h, 9^h, 10^h, and one plate 12^h—the exposures in some cases extending over parts of three nights during a week, and, notwithstanding the difficulties attendant upon those unavoidable conditions, the stellar images were remarkably round and sharp in outline. *Dr. Roberts* found when correlating the photographs taken last October, November, and December, with those taken the year 1888, that but little additional nebulosity and no certain

additional stars were depicted upon the photographs of 1897 beyond what were shown on those taken in 1888, notwithstanding the fact that the later plates were more sensitive than the first, and the exposures to the sky of the later extended up to 12 hours against those in 1888 with exposures during only four hours.

Dr. Roberts inferred from this evidence that there does not exist, in the group of the Pleiades or in the regions beyond or in front of the group, either stars or nebulosity fainter than is depicted on his negatives; and that the degree of faintness might be provisionally estimated at the light of 18th photometric magnitude stars.

Dr. Roberts described the nebula round *Merope* to be of a streaky character with the star in the centre of the denser part; the streaks trending in *south following to north preceding* directions for a distance of about 16 minutes of arc, and then curving in the direction *south preceding*, where the nebulosity becomes very faint, but still streaky in character, and spreads out to the extent of 50 minutes of arc in breadth. It did not seem to commingle in any degree with the other adjacent nebulosities, and there are four faint stars involved in it within a distance of 60 seconds of arc from *Merope*; besides these there are several other bright and faint stars involved in the nebulosity.

A straight streak of nebulosity extends across the two stars 1 and 7 (Bessel): it is about 19' in length, and does not seem to form a part of any of the other nebulosities. The author inferred that this is an independent nebula seen edgewise. There is a bright star at its centre, and four faint stars are apparently involved.

Electra does not seem to be involved in nebulosity; but there is a projecting streak of dense nebulosity which extends to a distance of about 14' from it towards the *following* direction, and is divided into two equal parts, along its full length, by a faint dark streak. Six stars of magnitude between 13 and 16 are apparently involved in this nebula, which Dr. Roberts thinks is seen edgewise and is independent of the others. The nebulosity which extends from *Maia* crosses the streak above referred to at an angle of 45 degrees, but no physical result seems to have been caused by this; which confirms the idea of the separate existence of both nebulae.

Alcyone is surrounded by nebulosity of both a streaky and flocculent character; the streaks on the following side trend *south following to north preceding*, and those on the preceding side cross the streaks of the *Maia* nebula, at nearly right angles, without appearance of either disturbance or of commingling. This again the author thinks points to the nebulae being independent. To the north of *Alcyone* is a streak of nebulosity 30 minutes of arc in length, curved towards the north, which involves the stars 10 and 24 (Bessel), besides 12 other stars between 12th and 11th magnitude. This he thinks is an independent nebula seen edgewise, and is probably of a spiral character. The north part of the *Alcyone* nebula seems to cross this streak without causing any disturbance to either of them.

Maia is surrounded by streaky nebulosity trending north and south in parts, and *north following* to *south preceding* in other parts. To the *north following* it extends in a long streaky arm a little beyond the star 12 (Bessel), a distance of about 44 seconds of arc, and on the *north preceding* side reaches *Taygeta*. There is also evidence of very faint nebulosity extending 30 minutes of arc on the *south following* side towards *Maia*. No clear proof is given that *Pleione* and *Atlas* are involved in nebulosity.

Dr. Roberts sums up that it appears to him that the evidence, taken as a whole, points strongly to the probability that the Pleiades consist of a group of stars seen by us either behind or else in front of a group of nebulae—*Alcyone*, *Merope*, and *Maia* being involved in nebulosity; but at present there is no indication of physical connection between the other nebulae and these three, or with each other. Dr. Roberts thinks that it will be an exceedingly difficult work to extend, materially, the knowledge we now possess concerning the group until movements and changes of structure can be detected amongst its components.

In a paper by Prof. Barnard published in the 'Monthly Notices,' vol. lvii. pp. 10–16, on p. 14 it is stated:—"At a meeting of the B.A.A. on April 29, Dr. Roberts took a further opportunity to object to these star pictures, and is reported to have said the exterior nebulosities shown on my Pleiades photographs were not nebulosity, and he made the assertion without fear of anyone proving the contrary. . . . That these nebulosities exist as shown on my photographs there can be doubt whatever."

Dr. Roberts pointed out that Prof. Barnard relied for proof of his assertion upon the evidence of only one very defective photograph; but that at his observatory he had taken several photographs, with exposures as long as or longer than were given to the plates taken and relied upon by Prof. Barnard, and that they certainly discredited Barnard's one photograph.

Dr. Roberts further said that Prof. Barnard, in his paper in the 'Monthly Notices' referred to, misquotes from his work—misconstrues his statements—gives measurements of the distances of certain nebulae on two of his photographs which are in error to the extent of so much as $2\frac{1}{2}$ degrees in 8 degrees on one, and 53 minutes in 4 degrees on the other—counts stars on a plate he had never seen, and of which he had no knowledge; then by that insinuates that his (Dr. Roberts's) count of the stars on another plate, which was sent to the Society, cannot be correct—states that Dr. Roberts had distinctly denied the existence of nebulosity in certain parts of the sky, whereas the reverse of this is true; for he had shown and published not only the existence but also the structural details of the nebulosity. He added that this list did not exhaust the erroneous statements made by Prof. Barnard in his paper.

Dr. Roberts also showed the results of some experiments he had made on the effects of atmospheric glare upon very sensitive

photographic plates, used in stellar photography, with the result that during exposures of two and a half hours and upwards such plates (films) are darkened when simply exposed in a box to the zenith in the sky as much as if exposed to the light of stars of the 16th magnitude.

By these experiments he showed that the vast areas of so-called nebulosity in the Milky Way are produced by the concentrated glare caused by the light of numerous stars in apparent close proximity by reason of the small scale of such photographs. They produce the appearance of nebulosity which is spurious and not real: its spurious character being proved by comparing two or more photographs of the same region and finding that the supposed nebulosity does not coincide either in density, extent, or position on any two of such photographs.

The President. I feel sure that Dr. Roberts's paper has been listened to by all with much interest, but I will defer asking for discussion on this for a short time, as Mr. Bacon, who has been kind enough to bring some photographs which he recently took in India, has to leave early, so that I will call upon him at once.

Rev. J. M. Bacon. Before my very few slides are shown may I just say one word to explain their purpose? It occurred to me that at the late eclipse I might, by a series of photographs, prove that the comparatively slow decrease of the light before totality, and the rapid return afterwards, is a mere subjective phenomenon. My daughter undertook the experiment, and having chosen a suitable landscape, made five identical exposures at intervals of ten minutes as the eclipse progressed. Then all the plates were developed together, the development being carried just so far as to bring out the detail on the darkest picture. Before we saw these results, it had occurred to us that the common theory that the mere rest to the eye accounts for the apparent sudden and accelerated return of light does not represent the facts accurately. At Buxar there was practically no rest to the eye. There were no stars seen during totality, excepting, of course, Venus. The whole duration was only 90 seconds, and I have a slide to show that the illumination during the total phase was vastly greater than that due to the full Moon in our own skies. In the first picture I have on one and the same plate a contrast between the light of the corona and that of the full Moon in England. The next slide, which has been lent me by Mr. Moore, will perhaps make this clearer. Various thicknesses of tissue paper are superposed on a sensitive film and exposed to moonlight. Beginning with a single thickness we go down to 30 thicknesses. It is clear that even when the light of the Sun was quite shut off there was still a very respectable amount of daylight. Now you will be prepared for the first of this series of five pictures which were taken. [Screen.] This was taken 35 minutes before totality had begun. The plate was overdeveloped; the detail was almost entirely blurred, and it simply suggests an overpowering glare of light. The next was taken 25

minutes, and the next 15 minutes before totality. You see in these that the shadows are very rapidly deepening. The next, which was taken 5 minutes before totality, shows the deepest gloom with the bright sky behind. There is a very considerable contrast between the picture before totality and that taken 5 minutes afterwards; as you see [screen] the second appears to be taken in a much brighter light. I advance no theory whatever: I simply suggest that the usual explanation may need some re-adjustment, and that in another eclipse the point should be investigated. During our expedition we took nearly 400 photographs of all sorts and conditions, and they seem clearly to establish three points—first of all, that in India plates are not very liable to over-exposure. The most convincing proof of that was furnished by the cinematograph. During the eclipse the film was geared to a very slow rate for use with the telescope. When the full light of the Sun returned I was asked to the tent of the Viceroy to take a picture. It was impossible to alter the gearing, and therefore impossible to drive it at a sufficient speed. It was expected that the picture would have been over-exposed, but it was not. Another point established was that it did not make a very great deal of difference whether a photograph was taken with a high Sun or a low Sun. The picture now on the screen was taken in the brightest light in the middle of the day. The next was taken quite late in the evening. They were similar plates and were developed in an almost similar manner. What makes the whole difference in a photograph seems to be the presence of water-vapour in the atmosphere. Those plates which were over-exposed in the country were taken in the neighbourhood of a broad sheet of water like the Ganges, and there is one picture which is very remarkable in its results. This picture was expected to have been very much under-exposed indeed. It was taken at 8 o'clock in the morning, early in February, and had to be taken as quickly as possible; but it is not under-exposed to any considerable extent, and the sky was immensely overcast, and there were actual drops of rain falling, showing that the atmosphere was over-charged with moisture. At Buxar, at the time of the eclipse, there was no moisture in the atmosphere, and yet I think it must be allowed that the brightness of the corona was much in advance of that of many other eclipses. It seems to me that matter in suspension is one of the most important factors, at any rate, in a photograph. I now show on the screen a photograph taken from the car of a balloon leaving the earth; but here everything is glared, although the same camera had taken a perfectly sharp picture before, and the explanation is, no doubt, that the particles in suspension in the air have their sunlit surfaces towards the camera. I submit, finally, that at the late eclipse the corona was brighter intrinsically, and not from any effect of Indian skies.

Mr. Newbegin. I should merely like to say how very striking

was the slide that Mr. Bacon showed us with those little black discs, illustrating the strength of the corona-light as against that of the full moonlight.

Dr. Spitta. I do not think the presence of moisture in the atmosphere as affecting exposure is anything new. It is a well-known thing that a photograph taken in the rain is very much more exposed than would be expected. Whether it is due to the rain in the act of falling or to the moisture in the atmosphere I do not know. In Switzerland I have taken photographs in pouring rain, so heavy as to have been obliged to cover the camera as well as I could; and yet there was a considerable amount of over-exposure. On showing them to an expert photographer in the trade, he told me that he always halves his exposure in rain.

Mr. Seabroke. I can quite corroborate what Dr. Spitta has said. A fortnight ago I took some photographs in Wales in the rain, and they were excellent. I had not thought of this reason before.

Capt. Noble. With reference to this series of photographs illustrating the superior density of the coronal light over that of moonlight, I think that books have hitherto exaggerated the intensity of darkness during a total eclipse. I was in Algeria at the time of the eclipse of 1870, and there the sky was densely clouded and itself comparatively very dark, but I could read the seconds on a Dent watch without artificial light at the time of the greatest obscuration.

Prof. Turner. It is hazardous to throw out a suggestion at a moment, but in connection with the great difference between the plate taken by Mr. Bacon after totality and the one taken before, it occurs to me that it is possible that this is due to the condensation of moisture which might have occurred owing to the fall of temperature during totality.

Mr. W. W. Bryant. Might it not possibly be that the air is much cleaner when it is raining?

The President. We are gradually gathering a harvest of extremely valuable results from the eclipse, but we have hardly had anything more interesting than that which Mr. Bacon has given us. This is another instance of the valuable work which was done by those who went out in connection with the British Astronomical Association, and we are very much obliged to Mr. Bacon for giving us an opportunity of seeing his pictures here. I now ask for discussion on Dr. Roberts's paper.

Mr. Franklin Adams. While some of the more learned members are thinking of starting the discussion, may I make one common-place remark applying to both papers. It is admitted even by the most experienced men that the photographs which are exhibited at our meetings are more or less educational for everybody, and nearly always somebody gets up and asks what plates they were taken upon. May I take the liberty of suggesting to

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the Council and the Secretaries that when these communications are sent in the sender should be asked to say, "taken on such or such a plate." It need not be in the form of an advertisement, but it would be of great interest to all the practical photographers in this room.

Dr. Spitta. I should like to ask Dr. Roberts one or two questions. The controversy between him and Prof. Barnard seems, so far as I can understand it, that certain nebulosities exist in the negatives of one that are absent in the other. I do not think Dr. Roberts need take the matter so keenly to heart, as he does not seem to have considered the possible effects of halation. I may say I have been engaged upon this subject for the past four years cutting sections of films about $\frac{1}{8000}$ th of an inch thick and then photomicrographing them. There may be said to be three kinds of halation—one from the back of the plate I call *post-halation*, one from the front *pre-halation*, and the third in which the light spreads laterally through the film from molecule to molecule. *Post-halation* is cured by proper backing; and my first question is, what kind of backing does Dr. Roberts use? *Pre-halation* is very difficult to cure unless you use plates of many films, the one lying in contact with the plate being almost insensitive. If some means be not adopted of this nature, it is extraordinary what a halo will surround a bright object after a long exposure and prolonged development. A paper negative is better than nothing, but is troublesome for other reasons. Here, then, is one source of trouble. But it is the third kind which I think may account—I don't say does account—but may account for some of the extraordinary lateral markings which we could all see on Dr. Roberts's photographs. This lateral spread is a most curious trouble. I speak of what I know, for I could show you shadows of very sensible length produced by particles in the film. I stumbled upon this form of halation, in the first instance, accidentally by having some plates made with a rather dirty emulsion or perhaps with large granules. It is not easy to show except under special arrangement. I know this is not a discovery on my part, for Capt. Abney predicted it some time ago, although I am not aware he ever showed a photograph of it. This I can do. I have not yet had the courage to bring these facts, and others equally curious, before the Society as yet, until, in fact, I have repeated them all for the third time. My second question, then, is to ask Dr. Roberts whether his plates were made of thick glass, whether the emulsion was also thickly laid on, and who made the plates?

Dr. Roberts made reference to, and told us of experiments made with the Warnerke photometer, but he says he does not know for how long he developed his plates. Now this is far more important than he thinks. To use this photometer properly you must compare equal times of development, and your developer must be of the same temperature approximately. A slow plate may show a speed of 25 and a fast plate a relative speed of 17 if these precautions are not

taken; and if inferences were drawn from these results they would evidently be most misleading. I don't make these remarks in a contumacious spirit, but merely in the nature of an enquiry upon a subject about which I have taken much interest and have made many experiments, and desire information.

Prof. Turner. When great photographers like Dr. Roberts and Prof. Barnard fall out other people perhaps will best further their interest by standing aside. We know that Dr. Roberts is a skilled photographer, and we also know Prof. Barnard. The only difference between them is that Prof. Barnard is not here; and I would ask Dr. Roberts if he does not think that some of his phrases should not remain in the proofs. I should at any rate wish to have no appearance of approving them, and so, I am sure, would others.

Dr. Roberts. In answer to Prof. Turner, I wish it to be clearly understood that I have not the slightest feeling of personal animosity against Prof. Barnard, and that I am simply criticising Prof. Barnard's work which is published in the 'Monthly Notices' (vol. lvii. pp. 10-16). If anyone will take the trouble to read that paper he will find ample material, after considering the remarks I have made upon it, to justify me in placing myself right concerning the wrong statements that have been made. At the time Prof. Barnard's paper was presented I was a member of the Council, but no intimation whatever was given to me that a paper, which on mere inspection would be seen to be both of a personal and of a controversial character, had been received or was to be read at a meeting of the Society, or to be published in the 'Monthly Notices.' The first knowledge I had of the paper and its contents was on reading it after publication, and I then sent some notes to the Secretaries, pointing out some of the inaccuracies in it. After considerable delay, I received a letter stating that the Council decided that it would not be advisable to print my notes.

I had not then the proofs that Prof. Barnard's distant nebulosities round the Pleiades did not exist; and the photo-proofs—six in number—with respective exposures of 8^h, 9^h, 10^h, and 12^h, were not obtained till October, November, and December last year. Some of these photographs have now been presented to the Society, projected on the lantern-screen, and it is seen that they are free from the defects of Prof. Barnard's photograph; and that they unmistakably demonstrate the non-existence of the nebulosities he described and illustrated in his paper, and in which one paragraph has the words, "That these nebulosities exist, as shown on my photographs, there can be no doubt whatever." This is a strong assertion for him to make when we consider that his evidence is founded upon only one defective photograph.

As to the words I have used in my present paper concerning the effects of smears and other dirt on the films of negatives, I would say that these are general statements that apply to myself as

well as to others; for accidents are liable to happen even to the most careful of operators.

Dr. Spitta's remarks extend over rather a wide field, and he must excuse me if I do not enter into details that do not concern my paper. Lateral extensions of the star-images, when restricted to the central bright nucleus of the image, are doubtless realities; but such extensions are confined to very small limits, and are entirely masked by the very much larger effects of diffraction and of atmospheric glare. The photo-images of stars brighter than fifth magnitude, which have been obtained by an exposure of the plates during several hours, are very much larger, and completely mask the lateral spread of the nuclei of the stellar images. Dr. Spitta has told the meeting that very coarse films produce certain effects, but I do not use very coarse films in my work.

The President. We are much obliged to Dr. Roberts for the beautiful photographs he has shown us. I will now call on Father Cortie to read his paper on Vanadium.

Father Cortie said that in examining the spectra of sun-spots in the red end of the spectrum, his attention had been drawn to the very great widening of some extremely faint lines, especially to a line about $\lambda=6243$. The lines thus widened in the sun-spots were hardly visible in the ordinary solar spectrum. Moreover they were permanent lines of the spot-spectra, widened in every spot, irrespective of the spot period. Since the publication of Professor Rowland's 'Preliminary Table of Wave-lengths,' he had been enabled to identify several of these spot-spectra lines as due to Vanadium. In a table in the paper presented, the behaviour of twenty lines of this metal which occur in the region C-D, and nearly all of them very faint lines, is contrasted in the spectra of the sun, spark, and spots. Several faint lines of Titanium and of other metals having an atomic weight of about 50 are similarly affected in sun-spots. This fact suggests that if we could determine the level of these faint lines of the metals of the average atomic weight, we might infer the mean level of the strata in which sun-spots are formed. Incidentally, as an answer to those who deny the objective reality of the widening of lines in the spectra of sun-spots, it was noted that of three lines of equal intensity between $\lambda 6192$ and $\lambda 6200$, the Vanadium line was always widened in sun-spots, while the other two have been frequently observed as unaffected in the same spots. The same was the case with two lines of equal intensity about $\lambda 6306$ due to oxygen, one of which was widened in sun-spots and the other unaffected. The widened line, curiously enough, is mapped as a solar line by Thollon, but possibly the widening of this oxygen line is due to some faint solar line contiguous to and, with the dispersion employed, coincident with the oxygen line.

Mr. Shackleton. At South Kensington we have been working in another region of the spectrum, namely from D to F. I have brought a lantern-slide of a portion of Rowland's map near D to

show some Vanadium lines which we always get widened. [Screen.] Vanadium has been shown lately to be a large constituent of certain Norwegian minerals. There is also a strongly widened line in spot-spectra which is due to Scandium, another mineral (as its name implies) belonging to the same country. One might almost think that the minerals of Norway, where also helium is found, had a direct connection with the solar atmosphere. In another region just beyond b there is also a Vanadium line, not represented in Rowland's map, which shows up very strongly in the spectra of spots. In a letter referring to some peculiarities in the "flash" spectrum, Prof. Young wrote to me "may they not be due to Vanadium, which cuts such a figure in sun-spot spectra?"

These few remarks I think will show that Father Cortie's results are thoroughly and independently substantiated.

Mr. Newall. It is interesting to find in how many directions the study of solar physics is throwing light on stellar physics. The Vanadium lines in star-spectra have attracted my attention in another part of the spectrum from that on which Father Cortie is working, and I should be very glad if he could extend his observations to $H\gamma$.

The President. I must express our thanks to Father Cortie for his extremely interesting communication, and to Mr. Shackleton for his addendum to it. We are glad to be able to welcome here to-night a very distinguished astronomer from Copenhagen, Prof. Thiele, and we shall be glad if he will speak to us for a few minutes.

Dr. Thiele gave a brief account of his investigations of banded spectra. He pointed out that banded spectra were more suitable as material for mathematical investigation than line-spectra, simply because they contained many more lines to be connected. The spectrum of helium investigated by Runge and Paschen is a good instance of a line-spectrum: in it each series converges, as it were, to a definite position in the spectrum, forming a "tail" into which an infinite number of lines of diminishing intensity are crowded. In a banded spectrum the striking feature is the existence of "heads" of bands in which a finite number of lines are collected. In banded spectra "tails" are seldom or never seen, though their existence is indicated in the mathematical investigation. Dr. Thiele remarked that he had been led to believe that in one of Rydberg's photographs of the cyanogen spectrum he could detect signs of the existence of "tails." The form of the expression which had chiefly engaged Dr. Thiele's attention as connecting the lines in a banded spectrum was such that in general a series must be regarded as composed of two sets of lines, one corresponding to positive values of n , and the other to negative values. The two "branches" thus alternately contributed a line to the series; or it might happen that the two branches coincided exactly, the resulting series of lines thus appearing more marked. In the green band of carbon (the candle-flame spectrum) Dr. Thiele had been

led by the mathematical investigation to look for six heads, and, guided by his calculation, had found two heads more than were previously recorded as observed.

Mr. Newall. I had great pleasure in hearing from Dr. Thiele the other day some account of his observations and calculations, and it was especially interesting to me to hear his remarks to-night about the discovery of heads in the green carbon band which were not ordinarily recognizable. It is always a satisfactory test to apply to such calculations, that they enable one to predict the existence of lines which ordinarily are not seen, but become visible when the positions are indicated by calculations. I am very glad to think that Dr. Thiele is not satisfied with having discovered the series in the carbon and cyanogen bands, but that he is ready to attack other banded spectra, if only the material is put at his disposal with sufficient accuracy of measurement.

The President. I think the Meeting will like to offer their sincere thanks to Prof. Thiele for his great kindness in honouring the Royal Astronomical Society with this visit and giving us this interesting communication. Any investigations of this kind, which tend to show how the various lines of the spectrum are linked together by geometrical relations, are always exceedingly instructive, for they have bearings not only on the immediate object such as Prof. Thiele had in view, but of course our ultimate knowledge of the molecular structure and movement of matter is largely derived from such observations and investigations.

Mr. Thackeray presented his determinations of the Proper Motions of Stars in the Greenwich Clock-star List, deduced entirely from observations made with the Greenwich transit-circle in the years from 1854 to 1896, and exhibited a diagram showing a comparison of these proper motions with the similar quantities as determined by Prof. Auwers and Prof. Newcomb.

Prof. Turner. I happen to be one of the persons who know what a vast amount of work a paper of this kind represents, and I should like to congratulate Mr. Thackeray on doing what I know has been contemplated at Greenwich for a long time, namely, the determination of a series of proper motions from the observations made by one instrument alone. The Greenwich transit-circle has been churning away for half a century, and does not yet show any signs of wear except in screws, which have been occasionally renewed. It is a wonderful instrument, and Mr. Thackeray's paper is only another testimony to its wonderful excellence as devised by Airy.

The President. I am sure the Meeting generally endorses the observations made by Prof. Turner.

The following papers were announced and partly read :—

William Anderson. "Notes on the Zodiacal Light."

T. J. J. See. "Micrometrical Measures of the Double Stars β 883, Sirius, and Procyon."

S. W. Burnham. "The Relative Motions of the Components of γ Leonis."

Rev. A. L. Cortie. "Vanadium in the Spectrum (C to D) of Sun-spots."

W. G. Thackeray. "A Determination of the Proper Motions of the Greenwich Clock-stars from the Greenwich Transit-Circle Observations, 1854-1896."

Royal Observatory, Greenwich. "Observations of Comet b 1898 (Perrine)."

A. E. Douglas. "The Markings on Venus."

Isaac Roberts. "Photographs of the Nebulæ in the Pleiades, of Stars in the Surrounding Regions, and of Spurious Nebulosity."

The following gentlemen were elected Fellows of the Society:—

George Banaster, The Mythe Villa, Tewkesbury.

Edward J. Essam, Billingsborough, Lincolnshire.

Hon. George Stuart Forbes, I.C.S., Revenue Secretary to the Governor of Madras.

Rev. William Edward Winks, 58 Richmond Road, Cardiff.

The following Candidates were proposed for election as Fellows of the Society:—

Andrew Ellicott Douglas, Lowell Observatory, Flagstaff, Arizona, U.S.A. (proposed by T. J. J. See).

Cecil Goodrick Julius Dolmage, M.A., LL.D., 22 Upper Merrion Street, Dublin (proposed by J. E. Gore).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE sixth ordinary Meeting of the Eighth Session of the British Astronomical Association was held at Sion College, on Wednesday, April 27, the President, *Mr. N. E. Green*, in the Chair.

A number of lantern-slides relating to the recent eclipse expeditions were exhibited, among them a series taken and lent by the Astronomer Royal.

Mr. Alfred Fowler then proceeded to give an account of the work of the expedition under the direction of Sir Norman Lockyer at Viziadrag. This party had the advantage of the assistance of a large number of the officers and men of H.M.S. 'Melpomene,' and therefore was able to carry out a very complete programme of operations. Twenty-two sections of work were organized by Sir Norman Lockyer, including almost every line of inquiry possible during an eclipse. The photographs taken with the coronagraph

and prismatic cameras were very satisfactory. One object in view with the latter was to register the spectrum of the chromosphere and prominences at various levels, and for this purpose special plate-holders were devised to permit of ten exposures at intervals of about a second.

Dr. Johnstone Stoney remarked that the divergence between the intensities of the bright lines of the chromosphere and the corresponding dark lines of the ordinary solar spectrum, to which *Mr. Fowler* had called attention, was exactly what might be expected. If a bright incandescent body, which is opaque, and which is interposed between the eye and a still brighter background is viewed, it appears dark in the contrast. In the same way, when we admit to our spectroscope light from the face of the Sun, we are looking through the chromosphere filled with its bright lines at the still brighter background of the intense continuous spectrum produced by the photosphere. Now it is a known property of incandescent gases to be more or less opaque for light of those particular wave-lengths which they can emit, and which produce their bright lines. Accordingly one dark Fraunhofer line is fainter than another, either because the chromospheric line which occasions it is intrinsically a brighter line, or because it is less opaque, or both. It thus happens that dark Fraunhofer lines which are faint are often caused by very bright lines in the chromosphere, and *vice versa*, and this involves those divergencies to which *Mr. Fowler* referred.

Mr. Schooling regretted that more attention had not been paid to the conduct of the natives on the occasion of the eclipse.

Mr. Maunder said that at the Camp at Talni there were no natives within sight except the police guard. They could, however, hear the wailing and cries in the village, where he supposed they were praying for the safety of the Sun during the eclipse, and wailing over its apparent dissolution.

A sketch by *Mr. Newall* was then exhibited showing the distribution of the hypothetical gas "Coronium" in the corona, as shown by the shape of the 1474 K line.

Dr. Johnstone Stoney asked whether the coronium line was seen to be more diffuse as well as fainter at a greater distance.

Mr. Maunder replied that, to his sight, it seemed to fade off gradually in proportion to its distance from the Sun.

The Secretary read a report of the Eclipse from *Mr. J. W. Meares*, of Darjeeling. No shadow was observed crossing the country. The long coronal streamer on the lower side became visible some two seconds before totality, and continued visible some five seconds after totality had ended. The brightness of the inner corona was far too intense to be compared in any way with the full Moon, even the streamers were brighter than the full Moon. The general brightness during totality was certainly as great as the light of two, if not three, full Moons.

Mr. Schooling read a paper by *M. E. M. Antoniadi* on "Further

Considerations on Geminatlon." Referring to the discussion that had taken place on this subject at the January meeting, M. Antoniadi maintained that duplication might be either optical or instrumental—instrumental by an exceedingly slight focussing error; optical by Dr. Andriegen's diploptic oscillations arising from an intermittent and uneven action of the muscles of accommodation. This is what should happen theoretically, and this is what actually does happen.

The Secretary then read a paper by the *Rev. W. R. Waugh* (the Director of the Section) on "The Aspect of Jupiter in 1898," and also a paper by the *Rev. T. H. Foulkes*, giving the results of some 50 observations of θ Orionis made at Malta. He had come to the conclusion that all the variability observed was due to atmosphere.

ROYAL METEOROLOGICAL SOCIETY.

THE Monthly Meeting of this Society was held on Wednesday afternoon, May 19, at the rooms of the Royal Astronomical Society, Burlington House, *Mr. F. C. Bayard, LL.M., President*, in the Chair.

Mr. R. H. Scott, F.R.S., read a paper on the frequency of rainy days in the British Islands. He had taken the number of rainy days in each month at 40 stations for the 20 years 1876–95, and then divided that number by the total number of days in the month, and so ascertained the resulting percentage. The greatest excess of frequency is always on the north and west coasts. June is the month with the least number of rainy days; but in July the summer maximum of rain occurs, bringing the well-known Lammas floods. In October the weather becomes decidedly showery, and the distribution begins to assume its winter type. November is the month with the greatest frequency of rainy days.

Mr. F. J. Brodie read a paper on the abnormal weather of January last, which was one of the most remarkable winter months on record. The month was singularly dry, with an absence of snow or sleet—a somewhat unusual feature in January even for any individual station, but far more remarkable as applying to the country as a whole. The special feature, however, was the striking absence of severe frost, the frequent prevalence of unusually mild weather, and as a result the abnormal warmth of the month, especially in the more northern parts of the kingdom. The mean temperature was generally over the whole country about 5° above the average, while at many places situated in the more northern parts of the kingdom it was more than 6° above the average. The atmospheric pressure throughout the month was also very high, the mean being from two- to three-tenths of an inch above the average.

*The Relation between Sun-spots and Magnetism *.*

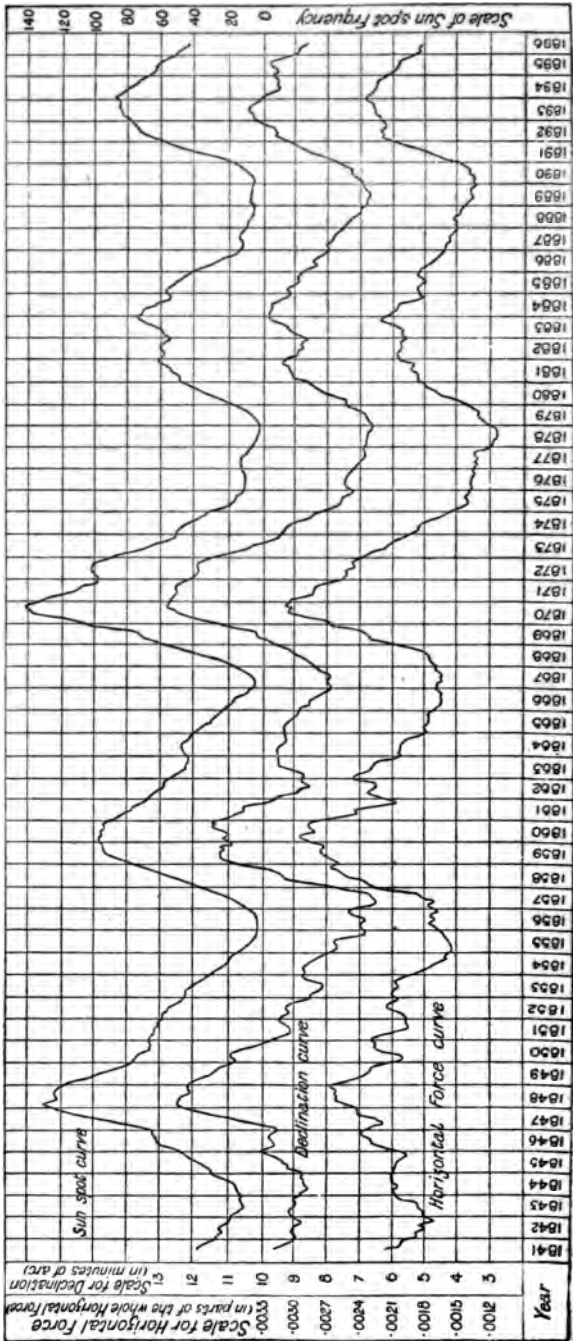
WHEN the rabid utilitarian in his superior manner asks the astronomer to expound the direct bearing of his researches on human affairs, the scientist, not infrequently with an air of triumph, points to the connection between the sun-spot cycle and that of disturbance of the magnetic needle as a fact which, after sufficient study, may prove to be of intense terrestrial interest, and so justifies himself by showing that his labours may not be without their practical value. We need scarcely say that we do not consider any such justification is necessary; but this same connection from any point of view is of much interest, and hence the recently published discussion by Mr. Ellis of observations, almost up to date, which treats of the question, seems to demand more than cursory notice.

The history of the subject is not ancient. The earliest suggestion of a "period" of magnetic disturbance appearance appears to be in a paper by Lamont in 'Poggendorff's Annalen' for December 1851, where he gave the variations of diurnal range of the declination-magnet at Munich in the years 1841 to 1850, which showed some evidence of a ten-yearly period. About the same time Sir Edward Sabine, discussing the magnetic observations made at Toronto and at Hobarton, found that there was a progressive increase of amount of magnetic disturbance at both these places between 1843 and 1848. As Schwabe had then recently published his table of frequency of solar spots, which showed a minimum in 1843 and a maximum in 1848, Sabine was led to point out, in his paper to the Royal Society of May 1852, the possible existence of a periodical variation in magnetism, similar to that in sun-spots, although at that time the years of observation on which both periods were based were few in number. Lamont was very sanguine about the reality of the similarity. Sabine, being more cautious, considered that more observations were necessary before any connection was proved, although the fact that the observations at such widely different stations as Toronto, Munich, and Hobarton agreed in showing a periodical variation of diurnal magnetic range was strong evidence of its reality. Since that time observations have been continued at Greenwich and other places, so that Sabine's criterion of sufficiency of evidence is perhaps satisfied, and the similarity, not to say connection, of the two periods may be taken as a proved fact.

In 1879 Mr. Ellis communicated to the Royal Society a comparison of the diurnal range of magnetic declination and horizontal force as observed at the Royal Observatory, Greenwich, during the years 1841 to 1877, with the corresponding numbers of sun-spot frequency as determined by the late Dr. Rudolf Wolf, of Zurich.

* "On the Relation between the Diurnal Range of Magnetic Declination and Horizontal Force and the Period of Solar Spot Frequency," by W. Ellis, F.R.S. Proc. Roy. Soc., vol. 63.

Smoothed Curves of Sun-spot Frequency (Wolf), compared with corresponding Curves showing the Variation in Diurnal Range of the Magnetic Elements of Declination and Horizontal Force from Observations made at the Royal Observatory, Greenwich.



The present paper discusses these observations anew, with the observations up to the end of 1896 added. Dr. Wolf's numbers (continued since his death by Prof. Wolfer, his successor at Zurich), which have been taken as data for the curves of sun-spot frequency, have been used in preference to the Greenwich sun-spot records, because this latter series has existed for not more than 23 of the years over which the discussion ranges, and it was thought better to adhere to the same system throughout.

Before stating the results of the discussion, it may be instructive to examine as briefly as possible Mr. Ellis's data and his method of treating the figures. The magnetic declination (and the horizontal force) as recorded by the Greenwich instrument is tabulated for every hour. The mean for each month of all the records at noon (say) and at each hour of the day are taken, and the difference between the greatest and least of the twenty-four mean values is the monthly mean diurnal range. These monthly means, which are given in the Greenwich volumes are the magnetic data of the paper and form Table I. From these numbers there is seen to be an annual inequality, *i. e.* the summer numbers are much greater than the winter, and hence, to estimate progressive change, means of every twelve consecutive monthly numbers are taken, and then the mean of each consecutive pairs of such means. These new monthly numbers form Table II., and have been plotted with the sun-spot monthly numbers, smoothed, in the same way as above described, to form three curves, which show respectively the sun-spot frequency and the variation in diurnal range of each of the magnetic elements. We have been kindly permitted to reproduce, on p. 236, the diagram showing these curves. It will be at once admitted that the accordance is most striking. The slight rise after depression of each of the curves in the middle of the year 1848, and in 1872, and again, but less marked, in 1884, is very remarkable. Noteworthy, too, is the fact that not only do the maxima of the three curves occur at the same time, but also when the maximum is less pronounced in one curve, it is also less pronounced in each of the others. There are other points no less remarkable, which can be seen from comparison of the curves, which lead irresistibly to the conclusion that the two phenomena of sun-spots and magnetic disturbance must depend on the same cause.

The tabular statement following, taken from Mr. Ellis's paper, gives conveniently the lengths of the sun-spot and magnetic periods. (The term "mean magnetic epoch" indicates the mean of the epochs for declination and for horizontal force, which vary somewhat in the first three cases).

Phase.	Mean magnetic epoch.	Sun-spot epoch.
Minimum	1843.60	1843.5
Maximum	1848.55	1848.1

Phase.	Mean mag- netic epoch.	Sun-spot epoch.
Minimum	1856·15	1856·0
Maximum	1860·40	1860·1
Minimum	1867·55	1867·2
Maximum	1870·85	1870·6
Minimum	1878·85	1879·0
Maximum	1883·90	1884·0
Minimum	1889·75	1890·2
Maximum	1893·75	1894·0

A little arithmetic will show how much the sun-spot period varies about the mean period of 11·57 years, but it will also show how closely the variation is followed by the magnetic periods, the mean of which is 11·42 years. Mr. Ellis suggests, but not very strongly, that the period decreases in length through several periods, then increases for several periods, and so on. In the earlier paper there seemed to be some evidence of a "lagging," that the magnetic effect followed the sun-spot effect, but the later observations now added do not bear this out. It is well known that occasionally the appearance of a large spot on the Sun is synchronous with a great magnetic disturbance, and it might be thought that such storms occurring at sun-spot maximum might in such a discussion as this affect the figures so as to show curves of variation which did not really represent the facts. Mr. Ellis has been able to disprove this by making curves from the five "quiet" days in each month between 1889 and 1896, selected by the Astronomer Royal, and these curves agree closely with those which depend on the observations of all days. The summation of the results of the paper cannot be given better than in Mr. Ellis's own words:—

"Considering that the irregularities in the length of the sun-spot period so entirely synchronize with similar irregularities in the magnetic period, and also that the elevation or depression of the maximum points of the sun-spot curve is accompanied by similar elevations and depressions in the two magnetic curves, it would seem, in the face of such evidence, that the supposition that such agreement is probably only accidental coincidence can scarcely be maintained, and there would appear to be no escape from the conclusion that such close correspondence, both in period and activity, indicates a more or less direct relation between the two phenomena or otherwise the existence of some common cause producing both. The sharp rise from minimum epoch to maximum epoch and the more gradual fall from maximum epoch to minimum epoch, may be pointed out as a characteristic of all three curves. The similarity of the little drop shown in all the curves in 1882 and 1883 is also striking."

May we be permitted to congratulate Mr. Ellis on this welcome and valuable addition to our knowledge of the subject, which he has made so entirely his own.

The Large Refractors of the World.

Lists of existing large telescopes have appeared previously in other places, but for obvious reasons such lists require occasional revision. The present table has been constructed with the help of the various makers who have been kind enough to send us details of their creations, so that there is reason for thinking it complete. With reference to the fourth column, with heading "Maker," the name of the firm who made the object-glass is given; in such cases as it is known that the mounting was made by a second firm, a number is affixed, signifying respectively: (1) Warner and Swasey; (2) Gautier; (3) Repsold; (4) Ransome and Simms; (5) Saegmüller; (6) Brunner; (7) Cooke and Sons; (8) Oavignato.

Aperture in inches.	Focal length in feet.	Institution.	Maker.	Date of Erection.	Remarks.
40.0	62.0	Yerkes Observatory, Wisconsin, U.S.A.	Alvan Clark (1).	1897	Visual.
36.0	57.8	Lick Observatory, California, U.S.A.	Alvan Clark (1).	1888	Visual.
33.0	49.2	Lick Observatory, California, U.S.A.	Alvan Clark (1).	.....	Photographic corrector for 36 in.
32.5	53.0	National Observatory, Meudon.	Henry Bros. (2).	1891	Visual.
31.1	39.4	Astrophysical Observatory, Potsdam.	.....	.....	Photographic. Not erected.
30.3	52.6	Bischoffsheim Observatory, Nice.	Henry Bros. (2).	1889	Visual.
30.0	42.0	Imperial Observatory, Poulkova.	Alvan Clark (3).	1882	Visual.
28.9	...	National Observatory, Paris.	Martin.		
28.0	28.0	Royal Observatory, Greenwich.	Sir H. Grubb (4).	1894	Visual and Photographic.
27.0	34.0	Imperial Observatory, Vienna.	Sir H. Grubb.	1878	Visual.
26.0	26.0	Royal Observatory, Greenwich.	Sir H. Grubb.	1897	Photographic. Presented by Sir H. Thompson.
26.0	32.5	Naval Observatory, Washington, U.S.A.	Alvan Clark (1).	1871	Visual.
26.0	32.5	Leander McCormick Observatory, Virginia, U.S.A.	Alvan Clark.	1874	Visual.
25.0	...	Cambridge University Observatory.	T. Cooke & Sons.	1868	Visual. Presented by Mrs. R. S. Newall.
24.4	52.2	National Observatory, Meudon.	Henry Bros. (2).	1891	Photographic.
24.0	11.3	Harvard College, Cambridge, U.S.A.	Alvan Clark.	1894	Photographic doublet. Presented by Miss Bruce.

Aperture in inches.	Focal length in feet.	Institution.	Maker.	Date of Erection.	Remarks.
24'0	22'6	Royal Observatory, Cape of Good Hope.	Sir H. Grubb.	1897	Photographic. Presented by Mr. F. McClean.
24'0	31'0	Lowell Observatory, Mexico.	Alvan Clark.	1895	Visual. { These telescopes on the same mounting form the Equatorial Coudé.
23'6	59'0	National Observatory, Paris.	Henry Bros. (2).	1889	Visual.
23'6	59'0	National Observatory, Paris.	Henry Bros. (2).	1889	Photographic.
23'0	32'0	Halsted Observatory, Princeton, U.S.A.	Alvan Clark.	1881	Visual.
21'8	...	Etna.	Merz.		
21'2	...	Buckingham Observatory.	Buckingham & Wragge.		
20'5	...	M. Porro, Private Observatory, Italy.	M. Porro.	1891	Visual.
20'0	28'0	Chamberlain Observatory, Colorado, U.S.A.	Alvan Clark (5).	1892	Guiding telescope for the
20'0	...	Manila Observatory, Philippine Isles.	Merz.	.....	31'3 inch.
19'7	41'2	Astrophysical Observatory, Potsdam.	.....		Visual.
19'1	23'0	Imperial Observatory, Strassburg.	Merz (3).	1880	Visual.
19'1	23'0	Milan Observatory, Italy.	Merz (3).	.....	Visual.
18'5	27'0	North-western University, Illinois, U.S.A.	Alvan Clark.	1863	Visual.
18'5	...	Dearborn Observatory.			
18'1	29'5	National Observatory, La Plata.	Henry Bros. (2).	1890	Visual.
18'0	26'3	Lowell Observatory, Mexico.	Alvan Clark.	1894	Coudé.
18'0	...	Flower Observatory, Philadelphia, U.S.A.	Brashear (1).	1896	Visual.
18'0	...	Vander Zee Observatory.	Fitz.		
18'0	22'6	Royal Observatory, Cape of Good Hope.	Sir H. Grubb.	1897	Visual.
16'5	26'2	Bischoffheim Observatory, Nice, France.	Henry Bros. (2).	1889	Coudé.
16'5	29'5	Imperial Observatory, Vienna.	Henry Bros. (2).	1890	Coudé.
16'5	22'5	Observatory of Jesuit Fathers, Zi-ka-Wei.	Henry Bros. (2).	1897	Photographic. } Same mounting.
16'5	23'0	Observatory of Jesuit Fathers, Zi-ka-Wei.	Henry Bros. (2).	1897	Visual.
16'0	...	Goodsell Observatory, Minnesota, U.S.A.	Brashear (1).	1891	Visual.
16'0	...	Warner Observatory, New York, U.S.A.	Alvan Clark (1).	1880	Visual.

16°	...	Professor Max Wolf, Heidelberg.	Brashear.	...	Photographic doublet.
16°	...	Professor Max Wolf, Heidelberg.	Brashear.	...	Photographic doublet.
15°	5'3	National Observatory, Mendon.	.....	...	For eclipse studies.
15°	6°	Harvard College Observatory, Cambridge, U.S.A.	Merz,	...	Photographic.
15°	20'3	Washburn Observatory, Wisconsin, U.S.A.	Alvan Clark.	1878	Visual.
15°	...	Dr. V. Cerulli, Peramo, Italy.	T. Cooke & Sons.	1885	Visual. Formerly belonged to Mr. Wigglesworth.
15°	...	National Observatory, Paris.	Henry Bros.	1882	Visual.
15°	...	Royal Observatory, Edinburgh.	Sir H. Grubb.	1873	Visual. Presented by Lord [Crawford.
15°	15°	Madrid Observatory.	Merz.	...	Visual.
15°	...	Dr. Huggins's Observatory, Tulase Hill.	Sir H. Grubb.	1870	Visual.
15°	...	National Observatory, Rio de Janeiro.	Sir H. Grubb.	1880	Visual.
15°	15°	Tacubaya Observatory, Mexico.	Lerebours (6).	...	Visual.
15°	29°	National Observatory, Paris.	Sir H. Grubb.	1893	Visual.
15°	15°	Stonyhurst College Observatory, Lancashire.	...	...	...
15°	...	Milan Observatory.	Sir H. Grubb.	1893	Visual.
15°	15°	Mississippi University.	Merz.	1846	Visual.
15°	22°	Harvard College Observatory, Cambridge, U.S.A.	...	...	...
15°	22°5	Imperial Observatory, Poulkova, Russia.	Merz & Mahler (3).	1839	Visual.
15°	15°	Mr. Dunn's Observatory, Maidenhead.	Sir H. Grubb.	1893	Visual.
15°	15°	Mr. Dunn's Observatory, Maidenhead.	Sir H. Grubb.	1894	Photographic.
14°	...	The Observatory, Odessa, Russia.	Merz.	1881	...
14°	23°	Bischoffsheim Observatory, Nice, France.	Henry Bros. (2).	...	Visual.
14°	22°4	National Observatory, Bordeaux, France.	Merz (2).	1880	...
14°	20°	National Observatory, Brussels.	Merz (7).	1877	...
14°	...	Lisbon Observatory.	Merz & Mahler.	...	...
13°	19°	National Observatory, Besançon, France.	Henry Bros. (2).	1887	Visual.
13°	25°5	Colonel Cooper's Observatory, Markree, Ireland.	Cauchois.	1834	...
13°	...	Hamilton College, Clinton, New York.	Spencer & Eaton.	...	...
13°	18°3	Catania Observatory, Etna.	Merz.	1891	...

CORRESPONDENCE.

*To the Editors of 'The Observatory.'**Ferrer's Cometary Observations at Cuba.*

GENTLEMEN,—

Perhaps at the present time it will be of some interest to recur to astronomical observations made on the island of Cuba early in this century by Don José Joaquín de Ferrer, of Cadiz, who died at Bilbao in 1818. They comprise, besides observations of the lunar eclipse of November 14, 1807, observations of the comets of 1807, 1811 I. (the great comet), and 1813 II. The paper giving an account of them, translated into English, was presented to the Astronomical Society by H. T. Colebrooke (the second President) on January 9, 1824, and appears in the third volume of the *Memoirs*.

The observations of the comet of 1807 were made partly in Havannah and partly in the house belonging to the sugar-works of Don José de Cotilla, situated in latitude $22^{\circ} 55' 16''$ N. and $44^{\circ} 3'$ E. longitude from Havannah*. Parabolic elements were computed by Don Francisco Lemaury, Lieut.-Col. of Engineers; but it subsequently appeared that the comet's orbit was elliptical with a period of nearly two thousand years.

The great comet of 1811 was in several respects the most remarkable of those bodies which has appeared within historic times. No record exists of one which was seen through so long an interval at one return to perihelion; it was discovered by Flaugergues at Viviers on the 26th March, 1811, passed its perihelion Sept. 12, and the last observation made was by Wisniewsky at Tscherkask on the 17th August, 1812, nearly seventeen months afterwards. As personal reminiscences at the Royal Observatory have lately had a place in your pages, perhaps I may be permitted to mention that, whilst looking with Sir George Airy at Donati's comet in 1858, he made the remark that he remembered the comet of 1811, and that his recollection of it was that it was not so conspicuous as Donati's. Ferrer's Cuban observations of the comet of 1811 commenced on the 18th of May in that year, and the last was made on the 9th of January, 1812.

Two comets appeared in the year 1813, both of which were first discovered by Pons—the first on February 4, the second on March 28. The latter was observed by Ferrer at Havannah from April 29 to May 17.

Ferrer speaks very highly of the climate of Cuba for making astronomical observations; let us hope that when the present war-cloud is over, advantage may be taken of its clear skies and a permanent observatory be established there. Ferrer's observations of comets were made with a sextant, and that of no great size;

* The latitude of the house in Havannah where the observations were made was $23^{\circ} 8' 30''$ N.

he felt a natural pride on finding that the orbits deduced by calculation from them agreed so well with those obtained from observations made with fixed instruments in Europe. In my little work on 'Remarkable Eclipses' (a third edition of which is now in the press) I had occasion to refer to his observations of the solar eclipse of June 16, 1806, at Kinderhook, in the State of New York.

Yours faithfully,

W. T. LYNN.

Blackheath, 1898, May 9.

Tempel's Periodic Comet (1867 II.).

(Translation.)

GENTLEMEN,—

In your number for March Mr. W. T. Lynn, in his letter "Periodical Comets due in 1898," made some remarks on Tempel's first periodic comet which are perfectly correct, but I ask to be allowed to add to these.

This comet has been observed successfully three times, in 1867, in 1873, and in 1879, and has not been seen since the last of these dates. It is probable that its intrinsic brightness, which had already diminished between 1873 and 1879, has continued to become more feeble, but, besides this, the conditions of the observation in 1885 were rendered less favourable by the fact of a change produced in its orbit under the perturbative action of Jupiter in 1879 and 1885. Whilst the value of the major axis was increased, the excentricity on the other hand diminished, so that the perihelion distance had constantly increased, whilst the aphelion distance, which has no effect on the observations, remained nearly the same. Here are some values of these quantities which may interest your readers (the distances are expressed in terms of the Earth's mean distance from the Sun as unity):—

Year.	Semi-major axis.	Excentricity.	Perihelion Distance.	Aphelion distance.
1867	3.175	0.5080	1.562	4.788
1873-1879..	3.295	0.4626	1.771	4.820
1885-1892..	3.483	0.4060	2.069	4.898

In the best possible conditions, the distance of the comet from the Earth in 1885 would have then been about twice that which it had in 1867. But, moreover, in the later year, opposition of the comet would have happened six months before its perihelion passage, and so it would not have been found.

In 1892 the time of opposition was much more nearly coincident with the perihelion passage. Unfortunately I had not had time that year to make the calculation with the same accuracy as for the preceding apparition. The ephemeris that I published was, however, approximate, and according to the computations that I have since made it would have furnished positions of the comet only a little different from the most probable.

For 1898 I have revised my calculations. I have computed the perturbations caused by Jupiter from 1885 to 1898, and I have just sent to the 'Astronomische Nachrichten' a detailed account of the work. The conditions of observation are, unfortunately, this year very like those which obtained in 1885. The opposition has already taken place on March 12 last, and the perihelion passage will happen on October 4 next.

I have nevertheless computed an ephemeris* of which I send you the beginning, valuable because it is important that observations of the comet should be obtained this year which will supply a control of the computed orbit of this object, whose motion shows some very interesting peculiarities.

The most probable values of the elements for 1898 are as follows, which are computed for 1898 April 4:—

M	....	332°	25'	25".3	
μ	....	542"	387		
T	....	1898 Oct. 4	0116	Berlin M.T.	
ϕ	....	23°	43'	0".4	
i	....	10	47	7.6	} 1898.0.
Ω	....	72	36	53.0	
π	....	241	16	57.6	

As the comet has not been observed for 19 years, I have wished to take account of the uncertainty which arises from the fact of the unknown perturbations which arose in the period from 1879 to 1885. I have calculated, besides the principal ephemeris, two ephemerides obtained by making the epoch of the perihelion passage to vary by 8 days in either direction. The real uncertainty ought to have a value less pronounced, because the comet will be found very probably in the region of the sky contained between the two extreme ephemerides.

I am, Gentlemen,

Yours faithfully,

Geneva Observatory,
1898, April 26.

R. GAUTIER.

GENTLEMEN,—

I owe an apology to M. Gautier for not including this body amongst the comets due to return in the present year. It will be remembered that, in the 15th volume of the 'Observatory,' p. 116, he corrected me for placing it amongst those due in 1891, his calculations having shown that the action of Jupiter, by diminishing the excentricity of the comet's orbit (increasing its perihelion distance without materially altering the aphelion distance), had shortened the periodic time, and another return to perihelion was in consequence not due until 1892 March 30. On that occasion the comet could only have been seen in the southern hemisphere; and I was influenced by a letter from Mr. Tebbutt, in *Ast. Nach.* No. 3144, in thinking that we must look upon it as a departed

* See page 246.

Friend. Mr. Tebbutt stated that he had made a careful search for it, according to M. Gautier's ephemeris, on June 19, 1892, "but, although the sky was brilliantly clear and the Moon absent, no trace of the comet could be found." M. Gautier has recently, as you are aware, published an ephemeris for the presumed return of this year, and we may hope northern observers may be more successful. But it is unfortunate that, although the perihelion passage is not due until October 4, the comet is already moving away from us and the nights are now very short.

Yours faithfully,

W. T. LYNN.

Blackheath, 1898, May 23.

OBSERVATORIES.

STONYHURST.—We have received, as we always do at this time of the year, Father Sidgreaves's neat little annual report of the Stonyhurst College Observatory. Besides the meteorological and magnetic results which occupy the greater part of the book, there is a page or two devoted to the astronomical work done. 174 drawings of Sun-spots and Faculae have been made during the year, and a series of enlarged drawings of spots near the limb has been begun as data for the discussion of the Wilsonian theory. A comparatively small number of photographs of stellar spectra have been taken, the time available for this work having been evidently used for the study of those already obtained. Complete wave-length charts have been made of 15 bright stars. Father Sidgreaves says "Our present work is directed to the sequence of spectral differences of the yellow and the red stars from those of the solar type to the type of α Herculis."

NOTES.

COMET NOTES.—Perrine's Comet continued to be a conspicuous object during May, being obvious at the first glance in a six-inch telescope. It has moved in almost perfect accordance with the ephemeris from Kreutz's elements, so that these must be nearly correct.

Ephemeris for Berlin midnight.

		R.A.			N. Dec.			R.A.			N. Dec.
		h	m	s				h	m	s	
June	1....	3	12	49	56° 20'	June	17....	4	13	2	55° 56'
	5....	3	29	19	56 21		21....	4	25	41	55 43
	9....	3	44	51	56 16		25....	4	37	43	55 25
	13....	3	59	25	56 7		29....	4	49	8	55 10

The brightness on June 13 is one-sixth of that at discovery.

Ast. Nach. 3490 contains the following elements of Encke's Comet by A. Iwanow :—

T	1898 May 26.836	Berlin M.T.
ω	183° 58' 57"	} 1898.0.
Ω	334 46 43	
i	12 54 37	
ϕ	57 49 15	
n	1074".292	

The following extracts from his ephemeris (for Berlin noon) will serve to correct those of Mr. David Smart given recently :—

R.A.				Dec.	R.A.				S. Dec.
	h	m	s			h	m	s	
June 1..	6	7	12	20 15' N.	July 11 ..	11	29	39	45 35
11..	6	49	55	12 20 N.	21 ..	14	26	27	49 9
21..	7	33	29	0 0	31 ..	15	55	59	44 26
July 1..	8	49	51	21 24 S.					

Ast. Nach. 3492 contains elements and a search ephemeris of Tempel's First Periodic Comet by R. Gautier. This comet was observed in 1867, 1873, 1879, but has not been seen since. The perturbations by Jupiter have been very large, increasing the semiaxis major from 3.2 to 3.5, and the perihelion distance from 1.6 to 2.1.

T	1898 Oct. 4.01	Berlin M.T.
ω	168° 40'	} 1898.0.
Ω	72 37	
i	10 47	
ϕ	23 43	
μ	542".39	

Ephemeris for Berlin midnight.

R.A.				N. Dec.	R.A.				Dec.
	h	m	s			h	m	s	
June 1....	11	41	11	13 50	July 11..	12	23	40	5 15 N.
9....	11	47	25	12 17	19..	12	34	58	3 20
17....	11	54	54	10 39	27..	12	47	2	1 23 N.
25....	12	3	31	8 55	Aug. 4..	12	59	46	0 36 S.
July 3....	12	13	8	7 7					

The probable error of the ephemeris is about 10^m in R.A., 1° in Dec.
A. C. D. C.

A TRANSIT INSTRUMENT IN THE PRIME VERTICAL.—The preliminary experimental observations with the new Altazimuth recently erected at Greenwich have induced some enquiries of a geometrical nature. We give here a few of the points of this kind that occur in the reduction of observations with a transit-circle in the prime vertical which may be found of interest. If we resolve

the rotation of $15''$ in a second of time of the Earth upon its axis, into two components, $15'' \sin c$ and $15'' \cos c$, where c is the colatitude, about horizontal and vertical axes in the plane of the meridian, it is clear that for stars on the prime vertical the one component has no effect upon the zenith-distance and the same effect for all stars upon the azimuth, while the other component has no effect on the azimuth and the same effect upon the zenith-distances of all stars. On the prime vertical, therefore, all stars approach or recede from the zenith at the rate of $15'' \sin c$ in a second of time, and all stars move in azimuth at the rate $15'' \cos c$.

The above result may be arrived at in a slightly different manner. Stars that at any instant lie on the prime vertical must always lie on a great circle, and after a *short* interval one point of the great circle will still be the zenith, since the diurnal motion there is along the prime vertical. The stars will therefore lie in another vertical circle, that is to say, their azimuths will be the same, and it is clear that the zenith-distances will all be altered by the same amount.

Azimuth-error may therefore be corrected by applying a constant to the time of observation; that is to say, adopting one clock-error for zenith-distance observations, and a different one for azimuth observations. If we assume a progressive change in the errors, we have only to adopt different clock-rates as well.

Clock-error is readily found from known stars by comparing the observed zenith-distance and time of observation with the tabular time of reaching the observed zenith-distance. Clearly all stars are equally suitable, except that for low stars there are uncertainties of refraction that might affect the determination.

The difference between the observed time of crossing the prime vertical corrected for collimation and level gives the clock-error and azimuth-correction combined. A subtraction will give the azimuth-correction freed from clock-error; but if it be required to judge of the trustworthiness of the observations in azimuth, it is undesirable to import into the result any imperfections there may be in the zenith-distance observation. It might be supposed that all stars are equally suitable for determining azimuth, as the correction for a given error is the same for each; but this is not so, for the difficulty of observing the time of transit will increase as the zenith-distance diminishes, owing to the decrease of the angle at which the star's path will cut the vertical wires.

An instrument in imperfect adjustment is parallel to a correctly mounted instrument at some other point of the Earth's surface. Level-error, for instance, corresponds to a change of latitude; azimuth-error to a change of longitude.

P. H. C.

TWO VARIABLE STARS.—Ast. Nach. No. 3483 contains an interesting paper by Herren Müller and Kempf, of the Potsdam Observatory, on the two stars U Vulpeculæ and ST Cygni, whose

variability has been previously announced. The result may be tabulated as follows:—

	B.D. No.	Epoch. Gwch. Time. d	Period. d	Magnitude. Max. Min.	
U Vulpec...	20.4200	1897 Oct. 2.47	8.000	7.0	7.6
ST Cygni ..	28.3460	1897 Oct. 4.66	3.844	6.6	7.4

The epochs given are for a maximum. In the case of U Vulpeculæ the light-curve is symmetrical—that is, the times from maximum to minimum and from minimum to maximum are equal, but there are small secondary variations. ST Cygni, on the other hand, rises from minimum to maximum in 0.9 day, and falls again to minimum in 2.9 days. The observations give reason for thinking that in the fall to minimum the brightness remains stationary for a period at about 1.75 days after maximum, being in this respect something similar to δ Cephei.

PHOTOGRAPHIC SPECTRUM OF THE AURORA.—In 'Harvard College Circular' No. 28, Prof. Pickering writes:—"Various attempts have been made at this Observatory to photograph the spectrum of the aurora. In 1886 on several occasions long exposures were given to plates during bright auroras but no result was obtained. On April 1, 1897, Mr. Edward S. King succeeded in obtaining a photograph in which four bright lines were visible, but uncertainty existed regarding their wave-lengths. The exposure was 147 minutes. During the bright aurora of March 15, 1898, he obtained a photograph showing two bright lines. The exposure was 141 minutes. The brightest of these lines extends in wave-length from about 3892 to 3925, and the wave-length of the second is 4285. Assuming the two brighter lines photographed in 1897 to be identical with these, the four lines on that plate have the wave-lengths 3862, 3922, 4288, and 4694. The first of these lines is very faint."

WEATHER PROSPECTS FOR THE COMING SUMMER.—The past month has been sufficiently un-May-like in character. The rainfall at Greenwich for the month was somewhat above the average, and the general gloominess of the month with a succession of excessively wet days about the 20th have tended to give a general impression, based on no very sufficient reason, that the coming season is likely to be a wet one. A correspondent in Symons's 'Meteorological Magazine' for May pointed out, *à propos* of a 19-year weather cycle, that the summers of 1860 and 1879 stand out in the memories of many as sunless and dripping, and that the summers of 1857, 1858, 1859 were respectively not unlike those of 1876, 1877, 1878, and also those of 1895, 1896, and 1897. He does not argue that because 19 years from 1860 brought a gloomy 1879 that *therefore* another 19 years *must* bring a gloomy 1898, but merely thinks

that the other coincidences give ground for watching whether 1898 will not prove like 1879 and 1860.

Nothing is easier to make facts and circumstances fit in with theories as to cycles and periods, but it is not unscientific to collect information which may bear on such a theory. There is abundant record that the year 1594 was a very wet year. In Stowe's 'Chronicle' it is said of this year that "In the month of May fell many great showers of rain, but in the months of June and July much more, for it commonly rained every day or night till St. James's day, and two days after most extremely; all which notwithstanding in the month of August there followed a great harvest, but in the month of September fell great rains." The above is extracted from the introduction to an edition of Shakespeare's 'Midsummer Night's Dream' by Prof. Morley, where he gives other references to show that 1594 was a remarkably unpleasant year, and, as this was about the time the play was written, suggests that this near experience of Shakespeare's is described in Titania's speech, Act II. Scene 2 :

That rheumatic diseases do abound;
And thorough this distemperature, we see
The seasons alter: hoary-headed frosts
Fall in the fresh lap of the crimson rose.

It need scarcely be added that from 1594 to 1898 is 304 years, which would exactly contain 16 cycles of 19 years each.

An obvious point in this matter would be to examine the records of the year 1841, although numerical records of rainfall are not exactly the data required, but rather general experience as to rain and want of sunshine during daylight hours. The records show, however, that in 1841 the temperature was low from July to October, and that there were a large number of rainy days in these months, but in both respects 1841 was not so marked as 1860 or 1879.

REMARKABLE ECLIPSES *.—In these days when general conversation turns much upon eclipses, it is the part of a wise man to prepare himself with some elementary facts on the subject. To this end we can heartily recommend Mr. Lynn's book with the above title, of which we have just received the third edition. The book is not a large one, fifty-two pages small octavo, and can therefore be comfortably carried in the pocket; and as it gives the salient points about solar eclipses from B.C. 776 to A.D. 1898, it may be judged that not much unnecessary information is given about each, but there is just enough to make the reader quite at home in the subject. Remembering much that we have read in the papers lately, the book should be in the reference-library of every newspaper office.

THE NEW DIRECTOR OF THE LICK OBSERVATORY.—In our last number we mentioned that Prof. James E. Keeler had definitely

* Edward Stanford: London, 1898. Price 6d.

accepted the directorship of the Observatory on Mount Hamilton. We are indebted to 'Popular Astronomy' of May for some particulars of this gentleman's career. Prof. Keeler is now forty years of age. While he was a student at the John Hopkins University (from 1877 to 1881) he went as a member of the 1878 Eclipse Expedition, under Prof. Holden, to Colorado. In 1881 he formed a member of the expedition which went with Prof. Langley to Mount Whitney, California, for the study of solar physics. After this he studied for a year or two at Heidelberg and Berlin; and on returning to America was appointed Assistant at the Lick Observatory, where he remained until 1889, when he succeeded Prof. Langley, now Secretary to the Smithsonian Institution, as Director of the Allegheny Observatory. His astronomical work has been mainly with the spectroscope. His spectroscopic determination of the constitution of Saturn's ring will be remembered.

PROF. SCHAEBERLE, who, with Prof. George Davidson, was an unsuccessful candidate for the post of Director, has resigned his position as Astronomer at the Lick Observatory. The Regents have accepted Prof. Schaeberle's resignation, to take effect one year hence, and have generously granted him leave of absence in the meantime on full pay.

NEBULÆ WHICH ARE NOT YET RECORDED IN THE CATALOGUES.—Dr. Isaac Roberts has been kind enough to send us for publication the following short list of Nebulæ, hitherto unrecorded, which he has found on his plates taken at Crowborough:—

Nebula in *Monoceros* in which the star 7.3 mag. Schönfeld D.M. No. 1848, Zone 10° south, is involved, together with several other faint stars. The nebula is irregularly round, bright, with a wide nebulous band across it in *s.f.* to *n.p.* direction. The nebula is about 13 minutes of arc in diameter. Co-ordinates of the star for the epoch 1855: R.A. $6^{\text{h}} 57^{\text{m}} 33^{\text{s}}.6$; Dec. south $10^{\circ} 14'.4$; mag. 7.3.

The nebula N.G.C. No. 2403 $\frac{1}{2}$ V. 44 *Camelopardi*, R.A. $7^{\text{h}} 27^{\text{m}}$, Dec. north $65^{\circ} 50'$, is a bright right-hand spiral, with several bright stars involved and numerous stellar condensations in the spirals; resembles M. 33 *Trianguli*; major diameter from *s.f.* to *n.p.* about 18 minutes of arc in length.

The nebula N.G.C. 2404 (Bigourdan) appears to be one of the numerous nebulous stars which form parts of this spiral nebula. There are also other small faint stars involved in nebosity within the distance of one degree of this nebula.

THE HISTORY OF THE NAUTICAL ALMANAC OFFICE.—The notes on this subject in our last number have brought us kind letters from Mr. Dunkin and Mr. Edward Roberts, both of which contain references to Mr. Robert Alger, of whom we said that we could trace no particulars. The extracts from these letters which we give here contain some information which it may be well to put on

record, and the second corrects a mistake in the last paragraph on p. 204, when we said that Edward Russel (his name should be spelled with only one "l") *succeeded* Alger and was *examined for his appointment*. These statements apply to Mr. Roberts.

Mr. Dunkin writes :—

Mr. Robert Alger was a most intimate friend (of my family) until his death in 1875 at Dartford, where he retired after a long service. He was a Devonshire man, hailing from Plymouth, and a most accurate and trustworthy computer. I can well remember him in 1838 putting me through a rather severe examination in arithmetic and the use of logarithmic tables at the request of Lieut. Stratford, who was anxious to know my capabilities before recommending me to the Astronomer Royal for service at the Royal Observatory. Lieut. Stratford's headquarters were then at 3 Verulam Buildings, Gray's Inn, at the office of the Metropolitan Loan and Investment Company, of which he was the Secretary; but the Nautical Almanac Office was at Somerset House, where it remained for some years.

By a slip of the pen you make my brother Richard the *second* son of Mr. William Dunkin. He was the fourth and youngest son. My two elder brothers predeceased my father.

Mr. Edward Roberts, who, it may be added, began his astronomical career, as did several others of the present Nautical Almanac staff, at Greenwich, writes :—

Robert Alger, having nearly lost his eyesight, retired from his office on 1864, June 30. It was Alger's calamity that caused a memorial to be forwarded from the Assistants to the Lords of the Admiralty, whereby the office obtained classification and Alger a retiring pension. Hitherto only the Superintendent was recognized by the Admiralty. He held his appointment by special warrant.

I succeeded Alger on the special nomination of Mr. Hind, on the recommendation of the Astronomer Royal, after a Civil Service examination, the first that was held on behalf of this office. My appointment bears date 1864, Nov. 5. I joined the Royal Observatory staff on 1860, July 2, on the nomination of the Rev. R. Main.

There is now * no classification of the Assistants in the Office, other than the Chief.

THE ROYAL SOCIETY CONVERSAZIONE.—There was a large display of the results obtained during the recent Solar Eclipse at the Royal Society's rooms on May 11, all the official expeditions and the British Astronomical Association expeditions being well represented. Sir Norman Lockyer also gave a lecture on the work of the party at Viziadrug. The only other astronomical exhibits at the Conversazione were Mr. W. Ellis's curves showing the periodical variation in frequency of sun-spots and of the amplitudes of the diurnal magnetic movement, and Father Sidgreaves's diagrams on the spectrum of *o Ceti*.

THE Astronomer Royal lectured on May 10 in the theatre of the Crystal Palace, at the *Soirée* of the Photographic Society, on

* This is a comparatively recent arrangement. The two classes were merged in the year 1895.

the Total Solar Eclipse of January 22. Lord Crawford, President of the Photographic Society, occupied the Chair.

IN the list of Candidates selected by the Council of the Royal Society to be recommended for election as Fellows of the Society, we notice the name of one astronomer, Mr. Ernest W. Brown, M.A., Professor in Haverford College, Pennsylvania, U.S.A., and formerly Fellow of Christ's College, Cambridge. Prof. Brown's especial line of work is the Lunar Theory. He has communicated many valuable papers on the subject to the 'Monthly Notices' of the Royal Astronomical Society, the 'American Journal of Mathematics,' and the 'Proceedings of the Cambridge Philosophical Society.'

THE following paragraph, taken from the advertisement columns of a daily newspaper, is given as sequel to two paragraphs which were transcribed on p. 70 of the January number. We believe the fifty pounds has not yet been applied for.

£50 REWARD.—ABSTRACTED from the "receiver" of a Cinematographic Camera, a NEGATIVE FILM of the SOLAR ECLIPSE, believed to have been stolen, either at Buxar, India, or during the transit of packages from the Royal Albert Docks to the Egyptian Hall, on Thursday last.—The above reward will be paid by the Rev. J. M. Bacon, of Coldash, Newbury, for information leading to the conviction of the thief or thieves.

THE occultation of Venus on May 22 was observed by several instruments at Greenwich. Times of all four contacts were noted by one or more of the observers; but as there was a considerable amount of cloud about there is some doubt whether all these are trustworthy. Neither the Moon nor the planet were visible to the naked eye before or at disappearance; but immediately after the reappearance, which took place twenty minutes before sunset, there was visible to the naked eye for a few seconds, through a break in the clouds, the beautiful spectacle of Venus impaled, as it were, on the horn of the two-day old Moon.

FROM AN OXFORD NOTE-BOOK.

TURNING over the leaves of Sir John Herschel's *Essays** the other day, I could not but be struck with the number of passages which seemed to have a peculiar interest at the present moment, though, after all, it is not surprising that the words of an able and thoughtful man, written half a century ago, on themes connected with so progressive a science as astronomy,

* *Essays from the Edinburgh and Quarterly Reviews, &c.*, by Sir J. F. W. Herschel. London, Longmans, 1857.

should specially appeal to us when read in the light of our later experience. But the interest is not always an astronomical one, witness the following passage (p. 280):—

A great and wondrous attempt is making in civilized Europe at the present time (1848); neither more nor less than an attempt to stave off, *ad infinitum*, the tremendous visitation of war; and by removing or alleviating the positive checks to the growth of population, to diminish the stringency of the preventive ones, and to subvert continually increasing masses on a continually increasing sale of comfort. May it be successful!

On page 67 there is a fine passage of architectural metaphor in which occurs the following sentence:—

In the science of physical astronomy the scaffolding has been long stripped away, and its theory stands august and stately, with that air of nature which marks it as the intellectual shadowing forth of a sublime reality.

It would almost seem as if Dr. G. W. Hill must have had this passage in his mind (though it is also quite probable that he had never seen or heard of it) when he wrote the admirably lucid sentence about Gylden's work which has been once before quoted in these notes (April 1896, p. 175):—

Professor Gylden has nowhere removed the scaffolding from the front of his building, and allowed us to see what architectural beauty it may possess.

This was in Dr. Hill's Presidential Address to the American Mathematical Society in December 1895, and struck me at the time as explaining the odd fact that some mathematicians speak of this work with the greatest enthusiasm, while others will not commit themselves to a single step in the direction of commendation.

THE name of Dr. Hill crops up again in connection with a passage (pp. 25-26) in the Herschel essays, too long to quote in full, concerning the problem of three bodies, which reminds us forcibly how new are the ideas about relative orbits introduced by Dr. G. W. Hill (ably expounded by Mr. Cowell on p. 121 of the present volume of this magazine), wherein the eccentricity of the Keplerian ellipse is treated with scant courtesy as an accidental irregularity, of which the principal perturbations take precedence. Sir John Herschel, on the other hand, takes the view (quite recently discarded) that perturbations are only worth mentioning in a footnote as a qualification of his statement that "without supposing any adjustment of the weights and distances of the members of a system subjected to the law of gravitation," the planetary motions could "be performed all in one plane and all in perfect circles about the Sun." He adds that he does "not remember to have seen any mention made of the possibility of this case," which he deduces from the general proposition of Lagrange and Laplace about the sum of the squares

of the eccentricities (each multiplied by a constant). If this sum had been originally zero, all the eccentricities would be each and always zero; and thus the orbits would be each and always circular. The footnote mentioning perturbations was added in 1857.

THERE is another interesting footnote on p. 86, objecting, under date 1856, to the term *potential function* (as now in use), "as conveying an idea quite foreign to the general signification of the function, which is a purely geometrical one, or at least one to which the conception of mechanical force or power is altogether extraneous." The name proposed by Sir John in 1840, in the letterpress of p. 86, was "*integral proximity* of the attracting mass," an expressive term. Is the fitness of *potential*, as demonstrated by its survival, merely due to its being one word rather than two? But these quotations will exceed proper limits if I do not take care.

A COUPLE of months ago some statistics were given of the number of pages in the Reports of the R. A. S. Council in different years. This tabulation of statistics is a rather persistent disease, not lightly shaken off; but I am taking all the known remedies, and hope for a speedy convalescence. I cannot, however, conquer the impulse to tabulate here the mean hour of Council (R. A. S.) meeting for the past 20 years or so, during which it has advanced by just one hour. Five-yearly means are as follows:—

Period.	Hour of Meeting. h.	Period.	Hour of Meeting. h.
1873-77.....	2'9 P.M.	1888-92.....	3'4 P.M.
1878-82.....	3'2 "	1893-97.....	3'9 "
1883-87.....	3'4 "		

It would be a hasty generalization to assume that the progression was secular; but it seems worthy of attention for the reason that the heavy amount of Council business has been put before the Society as a reason against changing the present inconvenient evening meetings into the afternoon; and if this business is getting lighter, or is got through quicker, this question of change of hour might be reopened.

WE have had a rather exciting sale at Oxford this last month, the books and other properties of the late Rev. C. L. Dodgson (known to most of the world as "Lewis Carroll") having been put up to auction. They went for rather good prices: people in Oxford seem to know pretty well the market price of books, and are also ready to give a few extra shillings for sentiment when the library of an eminent man comes to the hammer. One of the

cheaper lots, for instance, which went for 42s., was De Morgan's Budget of Paradoxes, with a few odd volumes. I was not able to be at the sale more than a few minutes, and do not know what price was fetched by other books interesting to the scientific world, such as, for instance, the author's copies of 'Euclid and his modern imitators.' But I see from the 'Oxford Magazine' that the first edition of 'Alice in Wonderland,' dated 1865, and bound in vellum, with a short poem of 12 lines by the author to M. A. B. on the flyleaf, was purchased by Mrs. Bickmore for £50; the first edition of 'Through the Looking-glass' fetched £24, and so on.

How much, I wonder, does the world know of Lewis Carroll? Does it know that he was an Oxford don and a clergyman? "The Subwarden" in 'Sylvie and Bruno' is a touch of Oxford that may have enlightened some readers. Does the world know how fond he was of puzzles? Here is one that he made on rather original lines. The following five questions are all to be answered by the use of the same letters (all and no more) anagrammatically transposed:—

1. When are you going to make your will?
2. Shall I write it for you in pencil?
3. Under what circumstances may a man leave all his money to charities?
4. What did the uncle say when he heard this?
5. What did the nephew say when his uncle left him all his money?

It is a rather difficult puzzle to state properly, and this is not a puzzle-magazine: hence I had better give a little more help than usual. The answer to the first question is "Now, I think," and to the fourth is "Hint! I know." Perhaps the others can be guessed.

BUT does the world know further that Lewis Carroll was a mathematician, and that some of his best fun was made on mathematical subjects? Those who have read 'A Tangled Tale' know something of this side of his character. There is a delightful parody of Euclid which he made in 1865, that is worthy of a more permanent place in published and accessible literature than it has at present. It begins as follows:—

Definitions.

1. Plain superficiality is the character of a speech in which, any two points being taken, the speaker is found to *lie wholly* with regard to those two points.
2. Plain anger is the inclination of two voters to one another, who meet together, but whose views are not in the same direction.
3. When a Proctor, meeting another Proctor, makes the votes on one side equal to those on the other, the feeling entertained by each side is called *Right Anger*.
4. When two parties coming together feel a Right Anger, each is *said* to be complimentary to the other (though strictly speaking this is very seldom the case).
5. *Obtuse Anger* is that which is greater than Right Anger.

There is more of the same excellent kind, such as the immortal axiom :

Men who go halves in the same (quart) are (generally) equal to another ;

and the pretty quip on Representation :

That the principle of Representation was known to the Ancients is abundantly exemplified by Thucydides, who tells us that the favourite encouragement during a trireme race was that touching allusion to Polar Coordinates which is still heard during the races of our own time :

" $\rho_1 \rho_2 \cos \phi$ they're gaining."

THIS is, I fear, a long digression on Lewis Carroll, without much astronomical significance. But, oddly enough, when I opened the old scrap-book into which I had copied the parody quoted, I found in the place Mr. Perigal's poem on the constellation Taurus. (I think my memory does not deceive me in ascribing it to our dear old friend Mr. Perigal, who was 97 on April 1 last.) I have no right to quote the poem here, but one verse of it caught my eye—

As our symbol of repliance
 "In defence and not defiance,"
 Be our guardian and reliance ;
 Keep us still the favoured nation,
 Mighty as the Bulls of Bashan.

for the reason that the author seems to have anticipated the refrain of a popular song of the present day called 'Volunteers' :

With your motto in compliance
 "For defence and not defiance,"
 'Tis in you we put reliance,
 Volunteers, Volunteers ;
 You've your countrymen's affiance,
 Volunteers.

But when such dexterity is shown in rhyming, how is it that both gifted composers have overlooked the obvious rhyme *science*, not to speak of appliance, alliance, and others ?

As we have "dropped into poetry," I may perhaps call attention to the exquisite poem in 'Nature' for 1898 April 14, signed "G. M. MINCHIN," and entitled a "Balnibarbian Glumtrap Rhyme." It begins :—

Distant scintillating star,
 Shall I tell you what you are ?
 Nay, for I can merely know
 What you were some years ago.
 For the rays that reach me here
 May have left your photosphere
 Ere the fight of Waterloo—
 Ere the pterodactyl flew.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

JULY, 1898.

No. 268.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, June 10, 1898.

Sir R. S. BALL, LL.D., F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. TURNER, M.A., B.Sc., F.R.S., and
H. F. NEWALL, M.A.

THE Minutes of the previous Meeting were read and confirmed.

Mr. Newall. 75 presents have been received since the date of the last Meeting. Amongst these I should like to call attention to the third edition of Mr. Lynn's useful little book called 'Remarkable Eclipses.' The fact that it has run to a third edition shows how interest in this subject has increased. The Society is indebted to Mr. McClean for examples of his works on Comparative Photographic Spectra of Stars to the Magnitude $3\frac{1}{2}$, and on Comparison of Oxygen with the extra lines in the Spectrum of Helium. We have received from the Paris Academy of Sciences the twelfth volume of the edition of Laplace's works which is being published under their auspices; also volume vii. of the National Edition of the Works of Galileo, which has been presented to us by the Italian Government. We have also had sent us by Dr. Weinek two parts of his Photographic Atlas of the Moon; and I would like to call special attention to an interesting historical instrument, a transit instrument of 2 inches aperture of the 18th century, which formerly belonged to Dr. Longfield, of Cork, and has been presented to us by Miss Lecky.

A vote of thanks was accorded to the donors of the presents.

Prof. Turner read a paper by *Dr. T. J. J. See* on "Further Researches on the Orbit of γ Lupi."

The President read some extracts from a letter received from

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Dr. See in connection with this paper' and in relation to the catalogue of double stars made at the Dublin Observatory.

Prof. Turner. The remark in the letter about "the finest telescope Mr. Clark ever made" reminds me that when we were passing through America in 1896, after the eclipse of that year, Mr. Hough, of the Dearborn Observatory, said to me, with a sort of chuckle, that he was always glad to tell Mr. Clark that the glass he had at Dearborn was the finest he ever made. The point of that story lies in the application. The Dearborn telescope was made a good many years ago, and no doubt it was then the best Mr. Clark had ever made, but presumably there have been a good many bigger and better telescopes made since; but one can see the delight with which Mr. Hough would remind Mr. Clark of the fact that he never made a better one. It becomes of historical interest when we find Dr. See making the same remark about his telescope, and no doubt there are many other telescopes about which the same remark is made.

Rev. J. M. Bacon (presented a paper on the Actinic Qualities of Light as affected by Different Conditions of Atmosphere). In this enquiry, which is of importance to the astronomer as involving questions with regard to definition, I have been led step by step to the considerations to which I have arrived by the following series of tests often and variously repeated. Using in all cases uniform samples of sensitive paper or films, and, as far as possible, eliminating all accidental sources of error, I have, by means of subdued and prolonged exposures, made comparisons between the action of light proceeding from blue or grey sky, (1) after traversing a length of tube admitting no extraneous light and containing only air at the surrounding temperature; (2) after traversing the same length of tube containing various admixtures of smoke and floating mote particles of different kinds. As was expected, the action of light was impeded in proportion to the presence of foreign matter.

Similar experiments being repeated with the same media but diffused light being freely admitted on all sides, it was found easy so to arrange matters that a *slight* addition of white smoke rendered the action of the light more rapid, doubtless owing to the myriad reflections from the surfaces of its particles.

Next, experiments similar to the above were made with air at the normal temperature compared with air variously heated. Here it was generally found that heated air retarded photographic action until the sensitized surface itself became materially heated, when action might be considerably accelerated.

Mr. Bacon showed photographs that he had taken as experiments in support of his views, and further proceeded to point out that in moist weather the atmosphere is not only more transparent, but conveys more diffused light. He thought that this is not sufficiently explained by saying that floating foreign matter has been

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exactly the reverse effect happened. The explanation of this is very simple: in the second case the collodion film was heated by hot water, and then the collodion film was exactly the same as a gelatine film. Then there is the question about the luminosity of the sky and phosphorescence. I have made a great many experiments upon skylight and its spectrum, and I say it is not a hopeful thing to find phosphorescence in the sky. We know we ought to expect it in the ocean, because we know what causes it; but as to the sky I have a strong opinion it will be very difficult to run it home. There is one curious phenomenon which strikes me at the present moment, and which I had endeavoured to track to its source, and which is much more curious than the luminosity of the sky and twilight and so on, and that is the appearance of snow. Anyone who has compared and measured the luminosity of the snow-field with the grey sky will find that the snow-field is considerably whiter than the grey sky. If you reason with regard to the matter, you will find that ought not to be so, but it is so. There is no doubt that there is more light reflected from the snow-field than from the sky which illuminates it. I think that is considerably more curious than the luminosity of the sky which has been alluded to. Then Mr. Bacon asks for any experience anyone may have had regarding the intensity of light at various altitudes. I am very happy to refer him to a paper I read at the Royal Society some years ago on the transmission of sunlight to the Earth's atmosphere. There are two parts of it—one about the transmission of light at sea-level, and the other about transmission at various altitudes upwards to 3000 feet, and I hope it may be of some use to him to see that there is a very strict law which regulates it. The whole matter really comes to this—it is all an effect of smoke, fumes, and, especially, aqueous vapour in the air. It seems to me that in aqueous vapour there are two sizes of molecules, one small and one big: when small molecules are present we have scattering of light by particles; but when the molecules are larger the blue rays are scattered more than the red rays, and there is greater photographic action. It seems to me that the more one knows by experiment about these things the more explanations can be offered of questions which are important to the astronomer, and I have therefore been led on to enlarge on this subject, which has occupied my attention for many years, and I hope that my experience will be useful to Mr. Bacon in his balloon ascents.

Capt. Noble. I should like to say a word about the point raised by Capt. Abney in his interesting speech, which refers to the phosphorescence of the clouds at night. I have been in a country road on a moonless night when there has been a dense vapour of cloud, and yet everything has been brilliantly distinct; and I have been out on other nights when positively I could hardly see my hand before me without a lantern, and it has occurred to me that

this effect may have had its origin not in the clouds, but in the Earth itself. It is a matter of common observation that the luminous paint often put on a lucifer match box gives out light, and I have sometimes thought whether the Earth may not in some manner absorb the solar rays and give them out again, because it seems impossible to see how any light can come through a pall of cloud.

Capt. John Steele related a personal experience of St. Elmo's fire or phosphorescence. Once, when on the yard-arm of a ship in a gale, he was surrounded by a phosphorescent light, which fell in a stream to the deck. He also detailed an observation from the deck of a ship in the tropics, of the tops of mountains on an island 42 miles distant.

Mr. Seabrook. Capt. Abney has carefully explained to us why plates in certain conditions are over-exposed. I should like to ask Mr. Bacon whether the last plate he showed was exposed to the moist air. Was it possible that the effect was due to moisture on the plate or to moisture in the air? These are two very different points. In the case of a passing cyclone, as it approaches distant objects are indistinct, but when it has passed over it is well known that one sees distant objects with very great perfection.

Rev. J. M. Bacon. In my second picture the moisture in the air could scarcely have had time to affect the plate. The interval during which the steam was in the room before exposure was made was not more than a few seconds. I cannot conceive that the moisture affected the surface of the plate.

Prof. Turner. We are very fortunate in having Capt. Abney here to-night to speak to us on this paper. These questions are becoming very important to us in eclipse work, and I speak feelingly, as one who is at the present time dealing with the subject of photometry by Capt. Abney's methods, and I may recall to his recollection that one of the difficulties of eclipse photometry arises because the exposure of standard squares is made at a different time from the exposure to the corona. I have said that it is very convenient for us to have Capt. Abney here to refer to, and I will go further, and say it would be a greater advantage for us to know where to find complete written information on these points. I cannot imagine a more useful work either for a Committee of the Royal Astronomical Society or a Committee of the British Astronomical Association to undertake than to classify papers on photometry which would be useful to astronomers. Eclipse work is becoming photographic now, and we require information published not in the astronomical, but in the photographic papers. To have a complete catalogue of the titles of Capt. Abney's papers would be a great convenience to me personally, as no doubt it would to Mr. Bacon, who probably finds more difficulty than I in getting hold of such papers.

Capt. Abney. I have been rather pointedly referred to by the

Secretary, to whom I will answer presently ; but first I will make one remark about what Capt. Noble said as to the luminosity of clouds at night. I am quite convinced of this, that when the subject of the luminosity of snow has been fully worked out the answer will be found in the reason of this same luminosity of the clouds at night in various states. Anyone who has been in Switzerland on a dark night will know that the snow looks black, and the clouds white. Prof. Turner has alluded to my papers in rather a heartless way. I am sure that the Society will say that I am not to blame. A certain very distinguished chemist has taken the trouble to have the papers I have written to various Societies and periodicals catalogued, and a copy of the catalogue has been sent to me. I find I have been guilty of writing 750 papers or more, so this catalogue may, perhaps, help Prof. Turner. Regarding the exposure of the standard-squares for use at an eclipse, the sensitiveness of plates when exposed to feeble intensities of light and to strong intensities of light—I may say that the slow plate is much slower with feeble intensity of light than with a strong intensity of light, whereas a rapid plate is of comparatively the same sensitiveness whether the light is strong or weak. Therefore for all the plates Prof. Turner took to India he may be sure that the difference in sensitiveness to the light to which he exposed the scale of standard-squares, and of that of the corona itself, is not appreciable.

Prof. Turner. The squares were exposed in damp England, and the corona was photographed in dry India.

Capt. Abney. I think any difference from this cause would be less than ten per cent.

The President. With regard to what Capt. Abney has said as to the luminosity of snow, it calls to my recollection an occasion several years ago when I happened to be crossing the Channel at night with Sir Gabriel Stokes. It was a perfectly dark night, and he remarked on the fact that the foam was so distinctly visible. There was no question of phosphorescence from organic sources, but it may be something of the kind just spoken of. Another matter that may be noticed in this connection is the persistent streak of a shooting star, which is perhaps a form of phosphorescence. In 1866 one lasted so long that I had time to go from the top of Lord Rosse's Observatory and get a lantern and make twenty sketches of it before it disappeared. This discussion has been an extremely interesting one.

Mr. Wesley then exhibited on the screen some photographs of the eclipse of January last taken in India by Prof. Naegamvala ; also one taken by the Lick Observatory party with an exposure of one second with the 40-foot telescope.

Mr. Maunder. There can be no doubt as to the reality of the coronal curves above the two prominences. They are also shown clearly on the photograph, which was taken by the Astronomer Royal with 20 seconds exposure.

Mr. Gregory. I think that Prof. Naegamvala is to be congratulated on his successful photographs, especially when we remember that he took these without any European assistant, and in spite of much difficulty. The prisms and the telescope were received by him only a day or two before the eclipse, and he had barely a week in which to make all arrangements.

Mr. Maunder showed some slides of photographs of the eclipse taken at Jeur by the Superintendent of the Archaeological Survey in India, and some photographs of star-fields taken by Mrs. Maunder with a little camera when in India, and also some attempted photographs of the zodiacal light, of which, however, there was no trace on the photographs. The field covered was a square of 40° side, and there was not much falling off of the images quite up to the edge of the field. The lens of the camera was a Dallmeyer of $1\frac{1}{2}$ -inch aperture and 9 inches focus.

Prof. Turner. I should like to call attention to the immense value the lantern has been to us in showing the results obtained by different observers of the late eclipse. It may not be out of place to remind Fellows how very few years ago it was that we introduced the lantern to the meeting against some considerable conservative opposition; but I think the result has justified the innovation. The whole of the mechanical arrangements of the lantern are due to Dr. Spitta, and this may be considered an appropriate occasion for us to express our appreciation of his efforts.

Rev. F. Howlett. The first time the lantern was used in this Society was to show some of my drawings of solar spots; and I think it was considered such an innovation that the Council had to be consulted as to whether it was legitimate to introduce such a toy into one of the learned Societies.

(*Prof. Turner* here took the Chair.)

Mr. Hinks showed a diagram that he had prepared to facilitate the work of determining stellar parallax by photography, which is to be begun at Cambridge Observatory. The diagram supplied a ready graphical method of finding the most suitable stars for observation on any night of the year, with their zenith-distance and hour-angle.

He also gave a description of some investigations he had made as to the possibility of counteracting the effects of refraction on the driving of an equatorial by setting the polar axis in positions not parallel to the axis of the Earth. He exhibited diagrams which showed the effect of such purposely made mal-adjustment, when the telescope was pointed on stars at various parts of the sky. The conclusion arrived at was that by no such disposition of the polar axis was it possible to dispense with guiding and a hand control.

Mr. Dyson. I am not astonished to hear that Mr. Hinks finds it will be advisable to have a means of hand-control, and not to

trust to an entirely automatic means of guiding. I think one thing that would not permit this is the irregularity in the rate of the control pendulum, and I think that when he has got his polar axis accurately adjusted he will be well advised to keep it so; but I should like to add that I have had much pleasure in listening to his paper.

Mr. Hollis. May I mention a device they have in use at Harvard for correcting the rotation of the plate with respect to the guiding star that Mr. Hinks has spoken of. Displacement of the plate from any cause consists of a translation and a rotation. Guiding with one star corrects for the displacement of translation, and the plate rotates about that guiding star. Now at Harvard they have two guiding stars, one used in the ordinary way, but there is a mechanical means of rotating the plate about the eyepiece in which this star is seen, and another eyepiece which commands a second guiding-star at another part of the field. The observer looks in this second eyepiece occasionally, and rotates the plate so as to keep both guiding-stars on the cross-wires.

Dr. Rambaut. I am sure those who have to work with photographic telescopes will find great help from the paper. I agree with Mr. Dyson in thinking that Mr. Hinks is wise not to disturb the polar axis of the telescope and to depend on the same method of correcting in declination as is used for R.A. I would ask him whether he has noticed that the effect of the differential refraction in declination was discussed cursorily in a paper of mine to which he already referred. I pointed out in that paper how the change in the position of the guiding-star, as affected by refraction, might be dealt with in the same way as changes in the hour-angle. In connection with this subject I may say that I examined some plates taken by Dr. Roberts in order to test how far distortion can be accounted for by the difference of refraction between the guiding-stars and other stars. I wish to express my satisfaction at the paper, which will prove useful in work of such a character as observations for stellar parallax.

The Chairman then called on Mr. Swasey of Ohio to address the Meeting.

Mr. Swasey. I assure you it has given me great pleasure to meet you on former occasions, and it is with particular pleasure that I am with you to-night. I am glad to be able to thank you in person for the honour you have conferred upon me in electing me a Fellow of this Society. As many of you are acquainted with a few Fellows on the other side of the Atlantic, whom I have met recently, I will say a word in regard to them. One is Prof. Barnard and the other is Mr. Brashear. Prof. Barnard spent the night with me about two weeks ago. He is on his way to Flagstaff, and I trust we shall have a report from him of what he sees at that very interesting observatory. I was glad to learn from Prof. Barnard of the work he has taken up at Yerkes

Observatory and to know that the instrument in which I was somewhat interested was working to his satisfaction. He is observing night after night all alone, with no assistance whatever, and this shows that that great instrument can easily be managed by one man. He not only operates the dome but the lifting-floor by means of electric switches and button, and turns the telescope in any position. In regard to Mr. Brashear, you may be surprised to hear that he has taken up quite a new line of work. He has been appointed Acting Director of the Allegheny Observatory, and Mr. Brashear will at once begin the work of constructing the new observatory. Already about 175,000 dollars has been raised, and it will be easy for them to raise this to the 200,000 dollars required. The new telescope will be one of the most modern American type, and I am sure you will all know that if Mr. Brashear has anything to do it will be done well. I have been asked to say something about the work I am interested in, but I hesitate to do so. A work we took up about 3 years ago was the construction of a dividing engine. Now just as it is much easier to tell the speed of a trotting horse after it has shown its speed on the track than to say beforehand how fast it will go, so though it may be easy to say that this engine will divide accurate seconds of arc, to prove it is a more difficult thing. The work we have done with the engine appears to be very satisfactory and well up to our expectations, and I believe there is no error in the engine to exceed a second of arc. We worked for more than a year to reduce this error from a second and a half to a second. I mention this not meaning that we have accomplished more than others, but merely to show that if anyone attempts to construct a dividing engine which will divide less than a second of arc, he has a very difficult job before him.

The following papers were announced and partly read :—

John Tebbutt. "Observations of the Phenomena of Jupiter's Satellites made at Windsor, New South Wales, in the year 1897."

Cambridge University. "Occultations of Ceres and of Venus."

David Gill. "Reply to Dr. Rambaut's Note on the Effect of Chromatic Dispersion."

C. J. Merfield. "Right Ascensions and Declinations of Eight Stars in Aquarius, and their Probable Proper Motions."

T. J. J. See. "Further Researches on the Orbit of γ Lupi."

Rev. J. M. Bacon. "On the Actinic Qualities of Light as affected by Different Conditions of Atmosphere."

A. R. Hinks. "On the Attempt to Counteract by Instrumental Adjustments certain Effects of Refraction in Stellar Photography."

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H. F. Newall. "Note concerning Diffraction Phenomena."

Rev. T. E. Espin. "Second Catalogue of the Stars of the IV. Type."

A. R. Hinks. "A Diagram showing the conditions under which Observations for the Determination of Stellar Parallax are to be made."

Royal Observatory, Greenwich. "Observations of Comet β 1898 (Perrine)."

The following gentlemen were elected Fellows of the Society:—

Henry Ellis, Little Heath, Potter's Bar.

Peter Matthews, 102 Fenchurch Street, E.C., and 65 Gordon Mansions, W.

Capt. P. B. Molesworth, R.A., Trincomali, Ceylon.

W. J. Reynolds, 61 Fairholt Road, Stamford Hill, N.

William Edward Sparkes, 5 Roker Terrace, Sunderland.

The following Candidates were proposed for election as Fellows of the Society:—

Lieut. Tristan Dannreuther, R.N., F.R.G.S., H.M.S. 'Leander,' Pacific Station, Esquimaux, British Columbia (proposed by S. Wellesley Johnson).

Charles Thomas Whitmell, M.A., B.Sc., Invermay, Headingley, Leeds (proposed by G. A. S. Atkinson).

The following were proposed by the Council as Associates:—

O. Backlund, St. Petersburg.

E. E. Barnard, D.Sc., F.R.A.S., Yerkes Observatory, Williams Bay, Wisconsin, U.S.A.

S. W. Burnham, M.A., F.R.A.S., Government Building, Chicago, U.S.A.

Commandant G. Defforges, Service Géographique de l'Armée, Paris.

J. E. Keeler, D.Sc., F.R.A.S., Director of the Lick Observatory, San José, California, U.S.A.

H. A. Rowland, Johns Hopkins University, Baltimore, Md., U.S.A.

Wilhelm Schur, Observatory, Göttingen, Germany.

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE fifth ordinary Meeting of the Eighth Session of the British Astronomical Association was held on Wednesday, May 25th, at Sion College, Victoria Embankment, *Mr. N. E. Green*, President, in the Chair.

The election of ten new Members by the Council was confirmed, and the names of two Candidates for Membership were read and suspended.

Mr. E. Holmes read a short paper in which he discussed the usual text-book descriptions of aberration, and pointed out that almost all ignored the effect of the motion in space of the solar system, and he suggested that careful observation might afford some indication of the direction and velocity of the Sun in space.

Mr. Crommelin thought it was a fallacy to suppose they could get any independent verification from aberration as to the true direction or speed of the solar motion. *Mr. Holmes* was perfectly correct in assuming that the motion of the solar system would produce an aberration of nearly as great an amount as the constant of aberration due to the Earth's motion; but this would be for ages a constant in the same direction, so that the only effect would be that the little aberration ellipse of the star would be shifted in a certain direction. There would be no change in the little aberration ellipse itself.

Mr. Seabroke thought that mention of the aberration due to the motion of the solar system was omitted in text-books for the sake of clearness and to prevent confusion. It was always usual in astronomical works—and very rightly so—to take one motion at a time. It was usual, for instance, to represent the Moon's orbit as a circle round the Earth, whereas the actual motion was not a circle at all, it was a figure that was concave to the Sun everywhere.

Mr. J. H. Bridger contributed a paper on "The Tint of Jupiter's North Polar Region," in which he drew attention to the decidedly bluish tint which the planet's North Polar region had exhibited during the present apparition, and suggested that the phenomenon was possibly due to electrical discharges of some kind in Jupiter's atmosphere. *Mr. Waugh*, in a note, remarked that this bluish tint had been characteristic of the North Polar regions for years past.

The President said he had noticed the blue tint at the North Pole again and again. He would describe it as oceanic rather than atmospheric, and felt very little doubt that if an extended sea existed over that portion of the planet it would produce that effect of colour. He had always been struck with the amount of colour, and strong colour, on Jupiter, which it was very difficult to represent without appearing to exaggerate. The drawings, in fact, required to be seen in the same subdued light in which they were made to give the true effect.

A paper by *Captain P. B. Molesworth* giving details of observations of the Zodiacal Light on March 14, 15, 16, and 17 last was read, after which *Mr. G. F. Chambers* made a few remarks on the Eclipse of May 1900. The path of the eclipse crossed Spain and Portugal centrally, touching the coast a few miles south of Oporto, and leaving it near Alicante. Oporto was very accessible from England, and the people very friendly, and those who dreaded the sea could travel nearly all the way by land. The totality, he thought, would be a little above the average, and the time would nearly coincide with a minimum period of sun-spots. The weather prospects were favourable, and a very pleasant trip, combining business with pleasure, might be anticipated.

Mr. Wesley said the question of the connection between the sun-spots and the corona was a matter on which we could not speak with certainty; but it seemed probable that as the corona of 1867 was very closely repeated in 1878, and that again in 1889, and as another eleven years would bring them to 1900, we should then have a corona of the same kind. It appeared to him that the changes of the corona had followed an eleven-year period, rather than the somewhat irregular period of the sun-spots, which was only a kind of average of eleven years.

Mrs. Crommelin remarked that *Mrs. Todd* in her little work on eclipses had pointed out that in the coming eclipse there would be an opportunity of getting many accessible stations both at the east and west ends of the track of totality. There were two advantages in this; one was that it reduced the likelihood of disappointment all along the line, and the other was the possibility of detecting changes in the corona. It might be possible, in case of anything very sensational being detected at the western stations, to send a telegram to the eastern stations in time to obtain confirmation.

Mr. Newbegin said that the Rev. J. M. Bacon was in favour of an Eclipse Expedition to the Gulf of Mexico.

Mr. Wesley remarked that totality would be short in the Gulf of Mexico, and longest in the Eastern States.

Mr. Schooling said there were many interesting aspects of astronomy which were not brought forward and discussed at the meetings of the Association, that might well be occasionally considered. Apart from the interest of the ideas themselves, the progress of thought about astronomy illustrated in a singularly happy fashion the progress of thought in general. The phenomena observed have, speaking generally, been unaltered for centuries, and have always attracted attention. In this respect astronomy was, perhaps, unique, and the primitive methods, the rude guesses at explanation, the ideas of astrologers, and the various gradations of sounder knowledge were interesting illustrations of different ways of looking at the same thing. The gradual development of science out of myth as seen in astronomy was only

one aspect of the subject which the Association might find it interesting to consider from time to time, and if members would occasionally contribute a paper on some bypath of astronomy he had no doubt the Council would be glad to receive them and have them read.

ROYAL METEOROLOGICAL SOCIETY.

THE Monthly Meeting of this Society was held on Wednesday afternoon, June 15, at the rooms of the Royal Astronomical Society, Burlington House, *Mr. F. C. Bayard, LL.M.*, President, in the Chair.

A paper by *Mr. R. C. Mossman* was read on the "Frequency of Non-Instrumental Meteorological Phenomena in London with different winds from 1763-1897." In previous papers the author has discussed the secular and seasonal variation of various phenomena, and he now gives the results of an analysis of the direction of the surface-winds observed during the occurrence of snow, hail, gales, thunderstorms, lightning, fog, and aurora. Snow is of most frequent occurrence with north and east winds, and least common with S.W. winds. Hail-showers occur most often with W., N.W., and N. winds. Gales are most frequent with W. and S. winds. The greatest number of both summer and winter thunderstorms occurs with W. winds, although the values in summer are high with E., S.E., and S. winds. The greatest number of fogs are recorded on calm days, closely followed by days on which the wind blew from the east.

A paper by *Mr. A. L. Rotch* was also read on "The Exploration of the Free Air by means of Kites at Blue Hill Observatory, Mass., U.S.A." After giving a brief account of the use of kites for scientific purposes from 1749 to the present time, the author described the various forms of kites which have been employed at Blue Hill Observatory, viz., the Eddy, or Malay tail-less kite; the Hargrave cellular or box kite; and the Lamson aerocurve kite. The highest flight was on October 15, 1897, when by means of four kites having a combined lifting surface of 150 square feet, the meteorograph at the end of 20,100 feet of wire was raised vertically 11,080 feet above the hill. About 200 records from kites have been obtained in the free air at heights from 100 to 11,000 feet in all kinds of weather. Mr. Rotch maintains that the kite can be made of the greatest importance for meteorological investigation. At the recent meeting of the International Aeronautical Committee at Strasburg it was recommended that all central observatories should employ kites as being of prime importance for the advancement of meteorological knowledge.

The Large Refractors of the World.

[Continued from p. 241.]

In the fourth column, with heading "Maker," the name of the firm who made the object-glass is given; in such cases as it is known that the mounting was made by a second firm, a number is affixed signifying respectively: (1) Warner and Swasey; (2) Gautier; (3) Repsold; (4) Ransomes and Sims; (5) Saegmüller.

Aperture in Inches.	Focal length.	Institution.	Maker.	Date of Erection.	Remarks.
13'0	135'1 inches.	National Observatory, Paris.	Henry Bros. (2).	1889	The first seventeen telescopes in the list are those in use for the making of the Astrographic Chart. The aperture and focal length of these are practically identical.
13'0	"	National Observatory, Bordeaux.	Henry Bros. (2).	1889	
13'0	"	University Observatory, Oxford.	Sir H. Grubb.	1889	
13'0	"	Tacubaya Observatory, Mexico.	Sir H. Grubb.	1889	
13'0	"	National Observatory, Toulouse.	Henry Bros. (2).	1890	
13'0	"	National Observatory, Algiers.	Henry Bros. (2).	1890	
13'0	"	Vatican Observatory, Rome.	Henry Bros. (2).	1890	
13'0	"	Royal Observatory, Greenwich.	Sir H. Grubb.	1890	
13'0	"	Melbourne Observatory, Victoria.	Sir H. Grubb.	1890	
13'0	"	Sydney Observatory, New South Wales.	Sir H. Grubb.	1890	
13'0	"	Royal Observatory, Cape of Good Hope.	Sir H. Grubb.	1890	
13'0	"	National Observatory, La Plata.	Henry Bros. (2).	1891	
13'0	"	San Fernando Observatory, Spain.	Henry Bros. (2).	1891	
13'0	"	Catania Observatory, Etna.	Steinheil.	1892	
13'0	"	Imperial Observatory, Potsdam.	Steinheil (3).	Mounted by Salmoiraghi.	
13'0	"	National Observatory, Rio de Janeiro.	Henry Bros. (2).		
13'0	"	The Observatory, Helsingfors.	Henry Bros. (3).	1895	
13'0	.....	Queen's College, Cork.	Sir H. Grubb.	1891	
13'0	.....	Temple Observatory, Taschkent.	Henry Bros. (2).	Photographic. Boyden Photographic.	
13'0	16'9 feet.	Imperial Observatory, Poulkova, Russia.	Henry Bros. (3).		
13'0	135'1 inches.	Perth Observatory, West Australia.	Sir H. Grubb.		
13'0	16'9 feet.	Royal Observatory, Leyden.	Henry Bros. (2).		
13'0	16'0 "	Harvard College Observatory, Cambridge, U.S.A.	.....		

12° 10'	.....	Dr. Urzula, Rio de Janeiro.	J. Cooke & Sons.	1894	
12° 15'	.....	Ann Arbor, Michigan, U.S.A.	Fitz.	1897	New triplet.
12° 15'	.....	University Observatory, Cambridge.	T. Cooke & Sons.	.....	Visual.
12° 13'	.....	Vassar College, New York.	Alvan Clark.	1875	Visual.
12° 13'	17° 0 feet.	Morrison Observatory, Missouri, U.S.A.	Alvan Clark.	.....	Mounted by Eichens.
12° 12'	17° 0 "	National Observatory, Paris.	Secretan.	1875	Visual.
12° 12'	14° 7 "	Oxford.	Sir H. Grubb.	1893	Visual. } By changing
12° 12'	15° 0 "	Dudley Observatory, Albany, New York.	Brashear (1).	1879	Photographic. } flint lens.
12° 10'	12° 0 "	Baron v. Engelhardt, Dresden.	Sir H. Grubb.	.....	Visual.
12° 10'	.....	The Observatory, Lyons.	Henry Bros.	1884	Visual. Coudé.
12° 10'	.....	McClean's Observatory, Tunbridge Wells.	Sir H. Grubb.	1891	Visual. Formerly at Ken-
12° 10'	.....	Yerkes Observatory, Wisconsin, U.S.A.	Brashear (1).	1868	wood.
12° 10'	.....	Middleton University Observatory, Con-	Alvan Clark (3).	1870	
12° 10'	.....	necticut, U.S.A.	Alvan Clark (5).	1881	Visual. Formerly Dr.
12° 10'	.....	S. V. White's Observatory, Brooklyn,	Alvan Clark.	1892	Draper's.
12° 10'	.....	U.S.A.	Alvan Clark (5).	1896	
12° 10'	.....	Lick Observatory, California, U.S.A.	Alvan Clark.	1895	
12° 10'	.....	Military Academy, West Point, U.S.A.	Alvan Clark (5).	1887	
12° 10'	.....	Naval Observatory, Washington.	Alvan Clark.	1894	
12° 10'	.....	University of Illinois, Illinois, U.S.A.	Brashear (1).	1889	
12° 10'	.....	Emerson McMillan Observatory, Ohio,	Brashear (1).	1893	
12° 10'	.....	U.S.A.	Davis (1).	1865	
12° 10'	.....	Smith College, Massachusetts, U.S.A.	Alvan Clark.	1886	
12° 10'	.....	Lowell Observatory, Mexico.	Alvan Clark (1).	.....	Mounted by Grubb.
12° 10'	.....	Cordoba Observatory, Argentina.	Brashear (1).		
12° 10'	.....	Protestant College, Beyrout, Syria.	T. Cooke & Sons.		
12° 10'	.....	Mr. Barclay's Observatory, Leytonstone.	T. Cooke & Sons.		
12° 10'	.....	Rev. J. Dunne Parker's Observatory,	Caucholz.		
12° 10'	.....	Stevenage.	Alvan Clark.		
12° 10'	19° 0 feet.	Dublin University Observatory, Dunsink.			
12° 10'	.....	Imperial Observatory, Vienna.			

CORRESPONDENCE.

*To the Editors of 'The Observatory.'**Comets long under Observation—a Correction.*

GENTLEMEN,—

In the third paragraph, line 3, of my letter to you dated May 9 (p. 242), for "No record exists" should be read "No previous record exists." As it stands, it would be true until within the last ten years; but, as Mr. Denning has kindly pointed out to me, Comet 1889 I. (Barnard's) was observed from 1888 September 2 to 1890 September 7, a total range of 735 days, or more than two years; and Comet 1890 II. (Brooks's) from 1890 March 19 to 1892 January 6, an interval of 658 days, or a year and more than nine months. According to Dr. Bidschof (*Ast. Nach.* No. 309, vol. cxxviii. col. 201) the orbit of the latter is hyperbolic; and the calculations of Herr Berberich (*Ast. Nach.* No. 2946, vol. cxxii. col. 275, and No. 2976, vol. cxxiv. col. 407), the motion of the former was also hyperbolic, though a definitive determination of its orbit has not yet been made.

Yours faithfully,

Blackheath, 1898, June 6.

W. T. LYNN.

Hour of Meeting of the Council of the Royal Astronomical Society.

GENTLEMEN,—

I was very glad to see the Oxford Note on p. 254 re the mean hour at which the Council of the Royal Astronomical Society has met during the last 24 years, showing, as it does, how, for some occult reason (possibly the private convenience of "some person or persons unknown"), such hour of meeting has gradually been getting later and later. As for the business becoming lighter or being got through more quickly, I, having sat upon the Council for practically the entire period under consideration, must absolutely decline to admit or accept this as any explanation or excuse for the gradual postponement of our hour of assembling. So far from this, what has really happened, every now and then, is that, owing to the lateness of the hour at which the Council has met, while the first part of the business has been fairly well performed, part of the rest has been scuffled through in a perfunctory manner, and remaining matters of importance have, perforce, been relegated "to the next Meeting," because, for a reason needless to be here referred to, it has been held that the Council must break up by a certain time. So far as I know, there is nothing to prevent its assembling at 3 o'clock, and the Scientific Meeting of the Society being held at 5 P.M., like that of the British Astronomical Association. The convenience of this to the country Fellows would be very great indeed. Whether, however, the ordinary

meeting takes place at 5 or, as at present, at 8 o'clock, there can, to my mind, be neither doubt nor dispute that an earlier one of the Council would materially conduce to the efficient despatch of the Society's business.

Forest Lodge, Maresfield, Uckfield,
1898, June 8.

Yours faithfully,
WILLIAM NOBLE.

Early Eclipses.

GENTLEMEN,—

There are several matters in astronomy that depend more or less on our being able to fix the exact date of early eclipses. But the calendars in use at these times were imperfect, and the observation of the eclipse may not always have been recorded by an eye-witness and at the time. Can any of your readers refer me to any book (or books) in which I can find the original records of these eclipses, with a critical discussion of them, or even without such a discussion?

Of course if the date of the eclipse is fixed by reckoning back to it on some fixed principle of computation, the eclipse affords no confirmation of the principles which are assumed in fixing the date of it. It is essential for such confirmation that the date should be fixed by independent evidence. In how many cases have we such evidence of the exact day and hour of an early eclipse?

Yours truly,

Dublin, 1898, June 6.

W. H. S. MONCK.

[We understand that Mr. Monck does not ask for the name of such a book as Oppolzer's 'Canon der Finsternisse,' nor Newcomb's tables for computing ancient eclipses; but he wishes rather to find original records of observations by which such tables could be checked. We may begin by referring him to the Chinese record the 'Shu Ching,' and to Prof. Russell's article which appeared in this magazine in 1895, which refers to this.—Eds.]

Klinkenberg's Comets.

GENTLEMEN,—

Dirk Klinkenberg not only discovered, on Dec. 9, 1743, the finest comet of the eighteenth century (which passed its perihelion on 1744 March 1), but was also the first discoverer of three other comets (1743 II., 1748 II., and 1762 I.), and an independent discoverer of the comet of 1757, though he was on that occasion anticipated by five days by Gartner, who noticed it at Dorlkurtz near Dresden, on Sept. 11, whilst Klinkenberg saw it first at the Hague on Sept. 16. His observations of the latter were sent to Bradley, and a translation of his paper printed in vol. 50, part 2, of the 'Philosophical Transactions.'

Klinkenberg not only observed this comet, but calculated its orbit, and showed that it was not, as he tells us some people in his neigh-

bourhood thought, a return of the comet of 1682, which we know now did not appear until more than a year later. He seems rather unduly hard upon those persons who, he says, would, if the comet had proved to be identical with that of 1682, have pretended to knowledge superior to that of Newton and Halley; whereas the idea seems, on the first discovery of the comet, to have been a fair one, though disproved by subsequent observations. Bradley's are printed in Phil. Trans. vol. 50, part 1; he determines the orbit more accurately than Klinkenberg, but gives the perihelion passage on the same day, October 21, and adds that the elements will enable future astronomers to distinguish this comet upon another return, though, as they do not correspond with those of any previous comet, "we cannot at present determine the period thereof."

We should like to know a little more about Klinkenberg. According to Poggendorff's 'Handwörterbuch,' he was born at Haarlem in 1709, and died at the Hague in 1799 (a century ago next April or May). Besides other papers, he wrote on the transit of Venus in 1761, and on "eene kleine doch ongewoone sterre, dewelke het allereerst in Engeland is ontdektete" (afterwards known to be the planet Uranus), in 1783.

Yours faithfully,

W. T. LYNN —

Blackheath, 1898, June 11.

OBSERVATORIES.

ROYAL OBSERVATORY, GREENWICH.—The Annual Visitation took place on June 4, when the Board of Visitors, under the presidency of Sir Robert Ball, in place of Lord Lister, who did not attend, received the Astronomer Royal's Report for the period between 1897 May 11 and 1898 May 10. The following is extracted from the various sections:—

Buildings.—The building of the East and West Wings, which will complete the Physical Observatory, is proceeding. The heating-apparatus for the whole building has been fitted up, well as the electric lighting system, which has also been extended to the Altazimuth Pavilion. The building of the Magnet Pavilion is not yet begun, but the site, about 350 yards east of the Observatory, has been selected and the contract for construction entered into, so that the building will probably be completed this summer.

Transit Circle.—The number of observations of transits made was 11,441, of zenith-distance 10,626. The latter number includes 638 observations of the nadir and 536 observations of stars by reflexion. The annual catalogue for 1897 contains 5047 stars. The variation of the circle-reading of the nadir-point depending on the hour of the day, which was mentioned in last year's report,

still appears to exist. From observations in each of the years 1895, 1896, 1897, it appears that the reading of the nadir-point taken between 15^h and 21^h Greenwich Civil Time differs by about 0".2 from similar readings taken in the six hours following or preceding.

The correction for R—D during the year 1897 is remarkably smaller than in previous years, for which no reason is suggested. The colatitude found from observations in 1897 is 0".21 less than the adopted value, and the correction to the tabular obliquity of the ecliptic found from observations of the Sun in 1897 is +0".21.

Altazimuth.—Observations with the old altazimuth, which was constructed to Sir George Airy's design in the year 1847, and has since been used for observing the Moon, were discontinued on 1897 Nov. 29. The new instrument of this class has undergone various modifications of the nature of improvements and adjustments, and regular observations have been begun. The Moon has been observed with this six times in R.A. and five times in N.P.D.

Thompson Equatorial.—The 26-inch object-glass has been dismounted for the greater part of the year, and has been in Sir Howard Grubb's hands for refiguring of the lenses. Experimental photographs taken with the plates inside and outside the focus and varying distance between the lenses showed a coma in the images at a distance from the centre of the field, which could only be got rid of by refiguring. The 30-inch Cassegrain, which is on the same mounting, has been used for photographing the Moon and some star-clusters in the secondary focus. The spectroscope for use with this is not yet completely in working order, and no spectroscopic observations have been made during the year.

The 28-inch Refractor has been used chiefly for micrometric measurements of double stars. 273 double stars have been measured, each being measured on the average on two nights. The companions of Sirius and Procyon have been measured, as well as other interesting stars. During 1897 August and September this instrument was used for photography with the crown lens reversed, and measurable photographs of 17 double stars were obtained, the least separation being 1".3.

The work on the Astrographic Chart and Catalogue is proceeding satisfactorily. The number of fields still remaining to be photographed is 321 for the Chart and 240 for the Catalogue. The plates from Dec. 64° N. to 68° N., and about half of the zone between Dec. 68° N. and 69° N., have been measured. These measures, which form a catalogue of 41,000 stars, are almost ready for press. The sun-spot record has been continued as in former years. On 42 days in the year the Sun was free from spots. Comparing this number with the 6 spotless days mentioned in the last Report, it appears that the spot-cycle is approaching its minimum. During the period covered by the Report, 73 phases of occultations of stars by the Moon have been observed—37 disap-

pearances and 36 reappearances. Comet *b* 1897 was observed on five nights, and *b* 1898 on four nights.

The mean temperature of the year 1897 was $50^{\circ}3$, being $0^{\circ}9$ above the average of the 50 years 1841–1890. The records show that the winter 1897–98 was a particularly mild one; the mean temperature from October to February was $44^{\circ}6$, which is $2^{\circ}4$ above the average. This mean for these five months has only been exceeded three times since 1841.

OXFORD UNIVERSITY OBSERVATORY.—Prof. Turner's Report on the work of his Observatory from 1897, June 1, to 1898, May 31, which he presented to the Board of Visitors on June 8 last, is summed up by saying that the staple work of the Observatory has been the measurement and reduction of the plates of the Astrophographic Catalogue. Few plates have been taken during the year, as the Director thinks, and with much reason, that it is inexpedient to take plates which cannot be measured for some years, but prefers to concentrate all his forces on measurement and reduction. Thanks to the Royal Society, which has continued the Grant from the Government Grant Fund for the second year of the five for which it is expected it will be wanted, and has promised it for the third year, four micrometers have been in use—not all of them at the Observatory, for one is used by Mr. T. J. Moore, of Doncaster, a working gardener and an ardent astronomer, who adds to his income by measuring star photographs—and 280 plates have been measured during the year in two positions, which is equivalent to 560 plates in all. It may be remarked that at Oxford only the 6-minute images are measured. It has chanced that these plates have fallen in a rich portion of the sky, for the average number of stars on a plate was 366, and on a certain ten plates which were taken near the region of the Milky Way a total number of 10,000 stars was counted. The hugeness of this number leads Prof. Turner to consider whether it would be advisable not to measure more than 300 of the stars on any such plate, and has arranged a means of selecting the brighter stars by making the shortest exposure 1 minute long instead of 20 seconds.

The Oxford Zone comprises 1180 plates, and the total work already done on these is 448 plates measured, 255 of them reduced, and the reduction of 87 others is well advanced. Mr. Bellamy, who has charge of this work, and whom Prof. Turner commends in the warmest manner, is to be congratulated.

It is not difficult to remember that the Director of this Observatory is also a University Professor, and he himself evidently takes the view that the Professorship carries with it responsibilities, as high or higher than the Directorship. From a short paragraph in the Report we gather that, with the help of Mr. H. H. Champion and Mr. E. T. Whitaker of Cambridge, Prof. Turner has revived the teaching of Mathematical Astronomy in the

University of Oxford, he has arranged, for the first time, an examination in Astronomy for the Final School, and has done considerable teaching work, which would have been more but for his journey to India to observe the eclipse. It is to be hoped that the Board of Visitors supported Prof. Turner's application for the construction of a dwelling-house near the Observatory. Certainly the four practical astronomers on the Board must understand the convenience, not to say necessity, of this, and should be able by their personal experience to convert the opponents of the scheme, who appear to be the Curators of the Parks, and who possibly take a magnified view of their office.

WINDSOR, NEW SOUTH WALES.—Mr. Tebbutt, the energetic proprietor and almost sole observer of this private observatory, has kindly sent us his record of work for 1897. The observing weather during the year was very favourable, and Mr. Tebbutt is therefore able to make a good report. Clock-error was determined on 168 nights. One hundred and thirty-four phases of occultations of stars by the Moon were observed, mainly with the 8-inch equatorial. These observations were chiefly of the disappearances at the dark limb, but three disappearances at the bright limb, two reappearances at the dark, and four at the bright limb are included in the number. The greater part of these occultations are evidently of small stars, which are observed without any previous computation of the circumstances being made. This line of work might be recommended to any amateur who has a small telescope and a transit instrument as one which would furnish useful results without much effort. Mr. Tebbutt has also made observations of position, by comparison with neighbouring stars, of Uranus, Neptune, and four small planets, also of Perrine's Comet I. 1897, with a square bar micrometer on the 8-inch equatorial on 21 nights. Several observations of the phenomena of Jupiter's satellites were observed, and a series of 29 comparisons of the variability of R Carinæ made, extending from January 4 to August 31. We beg to be allowed to congratulate Mr. Tebbutt on a good year; but we regret to read in his Report that there are reasons which make it necessary for him to curtail, in some degree, his meteorological work. It appears that recent local legislation has increased Mr. Tebbutt's share of the taxes, so that he finds it necessary to retrench his expenditure in some direction. He pointed out to the Government that he would have to close his meteorological department, and suggested that the Government should continue this work. The authorities have in consequence agreed to continue the meteorological records which Mr. Tebbutt has carried on for so long at his own expense at Hawkesbury Agricultural College; but as this arrangement is not so complete as could be wished, Mr. Tebbutt is still making observations of rainfall and temperature at his observatory. One would have thought that the easiest plan would have been to subsidize Mr. Tebbutt.

BIDSTON OBSERVATORY, LIVERPOOL.—The work done at this Observatory during 1897 was mainly meteorological, so that Mr. Plummer's report calls for but short notice from us. The transit instrument, which with the clocks and chronograph appear to be in a satisfactory condition, has been used mainly for determination of time, 2579 transit observations were made on 172 nights during the year, which number includes some observations of circumpolar stars taken from a catalogue published by Prof. Auwers in *Ast. Nach.* No. 3440. The results of these are given in detail in the Report to show the stability of the instrument. Chronometers to the number of 193 were deposited for test and examination, as well as some sextants and thermometers. An automatic instrument for registering earthquake-waves, the property of the British Association, was set up last September; but no earthquakes had been registered up to the date of the Report, 1897, Dec. 31.

PUBLICATIONS.

IN the veracious history of *Don Quixote de la Mancha* it is related that, on a certain notable occasion, the valorous knight had reason to reprove his squire for his inordinate use of proverbs in ordinary discourse. It is satisfactory, however, to find that the worthy knight did not altogether condemn the use of these "concise and pithy sentences," but rather their indiscriminate and lavish use on every occasion. We do not suppose that our readers will need to be warned against Sancho Panza's fault on having Mr. Inwards's handsome book on '*Weather Lore*'* placed in their hands, although every facility is offered in this well-arranged volume to anyone wishing to appear "weather wise." It is impossible to speak too highly of the judicious way in which the author has selected and arranged his proverbs. Probably more use might have been made of the accurate notes of Luke Howard in the '*Climate of London*,' only those referring to clouds appearing to have been extracted. One or two small faults may be noted:—Luke Howard's book above referred to is not mentioned in the bibliography, and on p. 208 Criswick, H. C., is misprinted Chiswick, H. T. C. In the second edition of the book (London, 1893) the name is correctly given "Criswick."

The following proverbs taken at random will serve to show some of the fallacious ideas of *proverbial philosophers* (?) with regard to the influence of the heavenly bodies, &c., on the weather:—

Five changes of the Moon in one calendar month indicate cooler weather.

Two full Moons in a calendar month bring on a flood.

* '*Weather Lore: a Collection of Proverbs, Sayings, and Rules concerning the Weather.*' 3rd edition. By Richard Inwards, F.R.A.S. (London, 1898.)

Shooting-stars, as they are termed, foretell immediate winds from the quarter whence they shoot.

When changes of the Moon occur in the morning, expect rain.

The aurora, when very bright, indicates approaching storm.

If the Moon changes with the wind in the east, the weather during the Moon will be foul.

The list of first flowering of plants, and times of appearance of birds, based upon long-continued observation, may be found useful and instructive.

W. C. N.

THE RECENT ECLIPSE *.—We have received from Mr. Maunder a pamphlet containing a very clear account of his and Mrs. Maunder's work during the eclipse of January 22nd last. Evidently these two observers went out to India with abundance of enthusiastic hope to balance their slender equipment, about which they must have been just a little nervous; for we read, "It consisted of a small binocular, one eye-piece of which was fitted with a little direct-vision prism, and of a camera whose lens was $1\frac{1}{2}$ inches aperture and 9 inches focal length. We could not but compare with something like a feeling of dismay, this almost microscopic equipment with the magnificent instruments of the official parties. As a set off, however, he was "hampered with no restriction whatsoever, having received absolutely no financial help from the Public Body." The description of the photographs is admirable and embraces so much that we are sorry to be unable to afford space for the whole. "The attempt to photograph the four coronal streamers met with a most wonderful success. Our two long-exposure pictures—four times Taylor's limit—equivalent to $120''$ with F.15—showed the four principal coronal streamers to much greater distance than ever before. They can be clearly and unmistakably followed to distances from the Moon's centre three, four, four and a half, and six diameters respectively." A picture is given of this photograph. About two minutes after totality a plate was exposed for $1\frac{1}{2}$ seconds, which not only showed the brilliant arc of sunlight, but also an unmistakable coronal ring. Thus we have these two setting out in fear and trembling and bringing home what we may term two epoch photographs. For undoubtedly the equipment of future eclipse parties will be modelled on their lines, with, of course, better instruments; and in addition, the partial eclipses are by the second photograph raised to a position of importance amongst astronomical phenomena.

We have also received with great pleasure two positives of glass from America.

(1) Total phase: Moon's diameter $\frac{1}{8}$ inch; exposure 10 seconds.

* By E. W. Maunder, F.R.A.S. 'Knowledge' Office, 326 High Street, W.C.

Taken with the Floyd telescope of the Lick Observatory Expedition at Jeur.

- (2) Total phase : Moon's diameter $\frac{7}{8}$ inch ; exposure 1 second.
Taken with the 40-foot telescope of the same party at Jeur. (Prof. Campbell.)

These are two beautiful photographs. No. 2 might be taken for a reduction from the Astronomer Royal's large coronal picture (No. 4), although the detail is naturally less delicate near the limb. When the coronal photographs are finally compared we have no doubt but that the distinguishing characteristic of this plate will be the clearness with which it shows the dome-like structure of the corona immediately above the longer prominences. We heartily congratulate the members of this expedition.

NOTES.

COMET NOTES.—The past month has been an extremely active one in cometary astronomy, no fewer than three new comets having been discovered, and two periodic ones detected on their return.

The first new comet (*c* 1898) was photographically discovered by Mr. Coddington at the Lick Observatory on June 11, and independently by W. Pauly at Bucharest on June 14. The following orbit has been deduced by A. Berberich from observations on June 11, 13, 15 :—

$$\begin{array}{llll} T & \dots & 1898 \text{ Aug. } 4.48 & \text{Berlin M.T.} \\ \omega & \dots & 206^\circ & 9' \\ \Omega & \dots & 73 & 59 \\ i & \dots & 76 & 48 \\ \log q & \dots & 0.3185 & \end{array} \left. \vphantom{\begin{array}{l} T \\ \omega \\ \Omega \\ i \end{array}} \right\} 1898.0.$$

Ephemeris for Greenwich midnight.

	R.A.			S. Dec.		R.A.			S. Dec.
	h	m	s			h	m	s	
July 1....	15	19	25	36 10'	July 9....	14	57	8	39 19'
5....	15	7	50	37 50'	13....	14	47	17	40 37'

The comet was bright at discovery, and the brightness remained stationary for some days, but is now slowly diminishing.

The second new comet (*e* 1898) was discovered by Mr. Perrine at the Lick Observatory on June 14. This was faint at discovery, but the brightness is rapidly increasing, being nine times that at discovery on July 21.

The following orbit has been deduced by A. Berberich from observations on June 14, 16, 17 :—

T	1898 Aug. 4.75	Berlin M.T.
ω	235° 17'	} 1898.0.
Ω	252 2	
i	72 11	
log q ..	9.4441	

Ephemeris for Berlin midnight.

R.A.				N. Dec.	R.A.				N. Dec.
h m s				° ' "	h m s				° ' "
July 1....	5	9	56	52 23	July 13....	6	16	49	42 54
5....	5	33	1	49 47	17....	6	37	36	38 33
9....	5	55	18	46 38	21....	6	57	39	33 29

At the end of the month the comet gets too near the Sun for convenient observation, but as the perihelion distance is only 0.28, it is likely to become very bright and visible in bright twilight.

The third new comet (g 1898) was discovered by M. Giacobini at Nice on June 19. The following orbit has been deduced by Prof. Kreutz from observations on June 19, 20, 21. The orbit is uncertain, the middle observation not being well represented:—

T	1898 July 6.24	Berlin M.T.
ω	7° 36'	} 1898.0.
Ω	278 31	
i	166 45	
log q ..	0.2004	

Ephemeris for Berlin midnight.

R.A.				S. Dec.	R.A.				S. Dec.
h m s				° ' "	h m s				° ' "
July 3....	17	8	1	19 29	July 15....	15	16	26	11 59
7....	16	20	13	16 47	19....	14	53	17	10 22
11....	15	43	37	14 11	23....	14	25	11	9 5

The comet at discovery was of the 10th magnitude, 2' in diameter. On June 28 it rose to 1.4 times that at discovery, and then commenced to decline, being 0.6 on July 15.

The designation d 1898 belongs to Encke's Comet, which was detected by Mr. Tebbutt, at Windsor, N.S.W., its place on June 11^d 843¹ G.M.T. being R.A. 6^h 53^m 28^s.0, N. Dec. 11° 33' 55". The R.A. was 9.5 greater, and the declination 5' greater than the place given by Iwanow's ephemeris, which will therefore serve with tolerable accuracy during the present apparition. There is little chance of its becoming visible to European observers at this return.

The designation f 1898 belongs to Wolf's Comet (of 1884 and 1891), which was detected by Prof. Hussey June 16^d 23^h 11^m.9

G.M.T. in R.A. $2^h 16^m 18^s.93$, N. Dec. $19^\circ 42' 44''$, this place being in practically exact accordance with Thraen's ephemeris, given in the May number.

Mr. Perrine has deduced the following elliptical elements of his comet of March 19 (*b* 1898) from observations on March 19, April 8 and 28:—

T	1898 March 17.07	Greenwich M.T.
ω	$47^\circ 14' 49''$	} 1898.0.
Ω	262 24 43	
i	72 32 56	
$\log q$. . .	0.03918	
$\log a$. . .	1.65639	
$\log e$. . .	9.98939	
$\log \mu$. . .	1.06543	
Period.	305.2 years.	

With the exception of ω the elements closely resemble those of the comets of 1684 and 1785 I.; but ω differs too widely to render identity possible.

We continue the ephemeris of the comet from Kreutz's elements, which will probably require to be corrected by $+29^\circ$ and $-9'$ in the middle of July. These corrections have not been applied in this ephemeris, which is for Berlin midnight:—

R.A.				N. Dec.	R.A.				N. Dec.
h m s				° ' "	h m s				° ' "
July 1	4	54	17	54 58	July 13	5	22	37	54 3
5	5	4	22	54 40	17	5	30	46	53 45
9	5	13	49	54 22	21	5	38	16	53 26

The brightness on July 15 is one-eleventh of that at discovery.

A. C. D. C.

OBITUARY.—HENRY PERIGAL. On the last page of our last number kindly reference was made to the esteemed gentleman whose name is written above. We have now regretfully to announce that Mr. Perigal died on Monday, June 6 last, a few days after those lines were written. At gatherings of a scientific nature, at which Mr. Perigal was a regular attendant, he was pointed out to strangers, who could scarcely fail to remark his quaint and venerable personality, as a marvellous example of vitality, for it was hard to realize, seeing his activity, that his years nearly numbered a hundred; and also as the man who could not be convinced that the Moon rotates on its axis. Mr. Perigal came of a family noted for longevity, and whose beginning could be traced back to Sigurd, a Dane who, in the year 908, made a successful raid on Normandy, assumed the name of Perigal, and settled in France. The English branch of the family, of which the subject of this notice was the

head is the 10th generation, sprang from Gideon Perigal and his wife, Madeline Duval, of Dieppe, who as Huguenots suffered persecution at the time of the revocation of the Edict of Nantes, escaped from prison and settled in London. Mr. Perigal's father, who reached the age of 99 years, was one of thirteen children, nine of whom all attained a great age. Mr. Perigal was the eldest of six children, the youngest of whom, Mr. Frederick Perigal, is now in his 87th year. In his early life he was a clerk in the Privy Council Office, but was pensioned somewhat early, and subsequently joined Mr. Tudor, a family connection, in his stockbroking business.

The Society with which Mr. Perigal was most intimately connected was the Royal Meteorological, of which he was Honorary Treasurer for many years. He was also a member of the Microscopical and the Royal Astronomical Societies, the Royal Institution (the Friday evening lectures of which he attended with great regularity, the Mathematical Society), and of other learned associations; in fact for years his life was almost a matter of routine, his days being spent in his office in Threadneedle Street and his evenings at a scientific meeting. His personal scientific recreations lay chiefly in the region of mechanics and geometry; he has written on the geometry of lathe work, on the laws of motion, on the methods by which the Pyramids were built, on harmonic motion, cycloidal and other curves. He was an excellent lathe worker, and Prof. De Morgan writing of Mr. Perigal has shown that being familiar with circular motion in a lathe, and looking upon one circle moving upon another as in simple motion, if the second circle be fixed to the revolving radius he might have been led to the heterodox opinion mentioned above: although he was prepared to accept in substance the general accepted opinion as to the motion of the Moon, he would never agree that this entailed a rotation of the Moon on her own axis, and made diagrams and models for the purpose of convincing a disbelieving world that his own views were correct. He largely helped Prof. De Morgan and the late Mr. Proctor in the construction of their diagrams. That he was a poet of some sort may be judged from the specimen of his verse in our last number, and it might be written for his epitaph that he was a man busy with harmless eccentricities.

Mr. Perigal was 97 on April 1 last. He was never married, but leaves a large number of nephews and nieces. His intimate companion during his later years has been Mr. Washington Teasdale, who deeply feels his loss.

HERBERT SADLER.—We regret to announce the premature and sudden death, on the 1st of June, of Mr. H. Sadler, who, though he never occupied any stated position in astronomy, was yet well known by his frequent contributions to scientific periodicals, and possessed a knowledge of many branches of

astronomy. His acquaintance with the history and details of double stars was probably unique. He was born in 1856, and was the eldest son of the late Prebendary Sadler, author of a large number of highly-esteemed theological works, especially a series of commentaries on the books of the New Testament. Whilst the subject of our notice was yet a child, his father removed from the vicarage of Bridgwater to that of St. Paul's, Bedford, and it was there that he made the acquaintance of our late valued contributor, Mr. Elger, which led to the development of his son's taste for astronomy and his first practical familiarity with telescopic work. In 1869 the Rev. M. F. Sadler was appointed Rector of Honiton, Devonshire; but Herbert, after his education was completed, took up his residence in the neighbourhood of London, devoting himself to science in rather a miscellaneous sort of way, and was elected a Fellow of the R. A. S. in 1876, before coming of age. He became a Member of its Council in 1879, but so much indignation was excited by a paper criticising some of the observations and results in the Bedford Catalogue of the late Admiral Smyth, that it was thought better he should resign his seat. Subsequently, however, the 'Monthly Notices' have contained two papers from his pen—"Notes on a Catalogue of 10,300 Multiple and Double Stars forming vol. xl. of the *Memoirs*," and "Notes and Corrections to Sir John Herschel's Synopsis of all Sir William Herschel's Measures." In 1886 he published, in conjunction with Mr. Latimer Clark, a small work entitled 'The Star Guide; a List of the most remarkable Celestial Objects Visible with Small Telescopes.' Since then his name has chiefly appeared in print as a contributor to 'Knowledge' and to the 'English Mechanic'; occasionally, also, he favoured ourselves with a letter on some special subject, principally relating to double stars.

It is understood that for some years past he has been assisting Mr. Backhouse in the formation of an extensive catalogue of stars; but we are not aware how far this work has advanced towards completion.

W. T. L.

CYRILLE SOUILLART.—The death is announced, in his 70th year, of Prof. Souillart, of the Faculty of Sciences of Lille. The work to which this astronomer devoted thirty years of his life was the Analytical Theory of the Satellites of Jupiter*. His first publication was an essay on the subject in the 'Annales de l'École Normale' in 1865, which contained the germs of two memoirs, one published in the 'Mémoires of the Royal Astronomical Society' in 1880, the other in 'Mémoires des Savants étrangers,' tome xxx. These works together served as the foundation of the chapters on

* We are indebted for this information to an obituary notice by M. Callandreau in 'Comptes Rendus de l'Académie,' of May 23.

Jupiter's satellites that M. Tisserand included in his '*Mécanique Céleste*.' M. Souillart's theory is, to some extent, similar to that of Laplace; the method of the variation of constants with the addition indicated by Poisson of taking account of the rapid variation of certain elements is systematically employed. Prof. Souillart contributed many notes on his subject to the '*Bulletin Astronomique*.' He has not lived to completely finish his work; but his wish was, towards the end of his life, that some young astronomer would take up his work and construct tables from his theory.

Prof. Souillart had been elected, scarcely a year before his death, a Correspondent for the section of astronomy of the French Academy. He was elected an Associate of the Royal Astronomical Society on 1890, Dec. 12.

PROF. W. A. ROGERS.—The following facts about the late Prof. Rogers, whose death was briefly announced in our May number, have been taken from an obituary notice by Prof. Searle in *Ast. Nach.* 3449:—

William A. Rogers was born in Connecticut on 1832 Nov. 13, and after taking his degree in 1857, was made Professor of Mathematics and Astronomy in Alfred University, State of New York. In the early years of holding this office he took part, under W. C. Bond, in the work of the Harvard College Observatory, and in 1870 he was appointed to a post at Harvard, now under the care of Prof. Winlock. Rogers was placed in charge of the meridian circle, then newly erected, and it is by his work with this instrument that his name will be chiefly remembered. The observations for the zone of the *Astronomische Gesellschaft* Catalogue, declination $49^{\circ} 50'$ to $55^{\circ} 10' N.$, were made to a great extent by Prof. Rogers; and though in 1886 he left Harvard and resigned the post of Assistant Professor of Astronomy in the University, to which he had been appointed in 1877, to take up the Professorship of Physics and Astronomy in Colby University, he continued to superintend the reduction and preparation for press of the zone observations, and the complete catalogue was published a year or two ago as his work. Besides being an astronomer, Prof. Rogers was also an ardent physicist. He died on 1898 March 1, after an illness of several weeks brought on by a severe fall.

VARIABLE STARS OF SHORT PERIOD.—Prof. E. C. Pickering has devised a method for the wholesale discovery of stars of very short period, if such exist. The method, as might be expected, is photographic. A plate in a photographic telescope, mounted equatorially, is exposed to a field of stars for 10 minutes; 50 minutes later the plate is exposed for another 10 minutes, the telescope in the interval between the exposures being made to

almost follow the field, so that the second image does not fall on the first. The variation from celestial motion is contrived by displacing the polar axis, or by altering the clock-rate. This process goes on for (say) 7 hours, and, as a result, the plate shows lines of eight images of each star; for any short-period variable these images vary in size, and if the period be 16 hours or under, a maximum or a minimum, or both, will be shown on the plate. The sizes of plates used are such that the whole sky would be covered by 40 of them; and it is proposed to take these photographs shortly, by which it is hoped to secure a complete list of all variable stars of short period brighter than the ninth magnitude at maximum, whose variation exceeds half a magnitude, and whose period is less than a day. In the Harvard College Circular (No. 29) in which the method is described, a picture of a portion of a plate is given showing U Cephei and its variation, from which the method looks temptingly easy. It is to be hoped that this will be realized in practical application.

OBSERVATIONS WITH THE YERKES TELESCOPE.—Professor Barnard has obtained a very fine series of measures of the Satellite of Neptune with the 40-inch Yerkes refractor. As the first publication of work done with this magnificent instrument the article in *Ast. Journ.* No. 436 which contains these is of special interest. The remarks accompanying the measures give us a realistic idea of observing with the refractor:—"The period during which these measures were made (September to April) is the worst portion of the observing year; in the summer there are many quiet and beautifully steady nights, when it is expected the great telescope will work to the very best advantage. Actual work was not possible until the best season was essentially over. The occasional observations of the fifth satellite of Jupiter, of the close companion to Procyon, and a few similar objects, show that even a part of this unfavourable weather may permit the power of the telescope to be seen. On one or two occasions, when observing double stars, it has been possible to use powers of several thousand diameters, and on one date 3750 was used with good success. In all my work with the 40-inch, with different magnifying-powers, the object-glass seems to be entirely free from any form of ghost, and the definition has been very good. The driving of the clock has proved all that could be desired, and the stability of the entire instrument is very remarkable.

"One gets the impression from the bigness of the instrument that it must necessarily be clumsy to handle. Through the aid of the electric motors, however, it can be pointed to different parts of the sky with remarkable ease. The instrument was placed on the west side of the pier and pointed to the meridian at $+50^{\circ}$ dec. With the electric quick motors it was placed in a similar position

on the east side in 110 seconds. The dome, 90 feet in diameter, moves through a complete revolution in 6 minutes, while the floor descends its 22 feet in 3 minutes, and rises in $3\frac{1}{2}$ minutes. The telescope is protected from the wind by canvas curtains moving in the observing slit. A rather singular incident occurred in the early use of the instrument. When the telescope was first turned on the stars in August, after the accident to the elevating floor had been repaired, and before the dome and floor could be actively used, it was found that an objectionable broad beam of ghostly light ran through every bright star, and that, even with good seeing, no sort of definition could be got out of the glass. It had defined well before the accident, and the beam of light had not then existed. It was feared that some injury had happened to the object-glass, for the floor crashed against the pier in falling. The next day Prof. Hale and the rest of us examined the big lens by daylight, and it was then seen that some spiders had gained access to the tube. They had woven a perfect network of webs close to the inner lens on the side towards the eye end. It was at once suspected that these webs were responsible for the lack of definition and the beam of light—for they ran in the same direction as the beam of light. Mr. Ellerman climbed up inside the tube and removed the offending webs with a dust-brush. That night the beam of light had disappeared and the definition returned."

THE ASTRONOMICAL SOCIETY OF FRANCE.—We have read with much interest in the 'Bulletin' of this Society for May the address delivered by M. Flammarion, the General Secretary, at the Annual General Meeting on April 6, on the Progress of Astronomy and the work of the Society during the past year. The discourse touched on many things which it would serve no good purpose to recapitulate here, but amongst them M. Flammarion mentioned, *à propos* of the longevity of astronomers, that there are 13 Members of the Society of 80 years of age and upwards. Among these there are two Englishmen, Mr. Waugh, an occasional contributor of ours, and Mr. Blackwell, of Hastings. M. Flammarion also made some remarks on the apathy with which the majority of persons regard the science of astronomy, which he illustrated by reading extracts from some letters from provincial members. One of these writes:

Si je leur disais que nous voguons vers la constellation d'Hercule, ils me considéreraient comme un candidat à Charenton. Et plus d'un, j'en suis sûr, doit m'accorder une douce compassion à la vue de la modeste coupole établie sur ma maison.

And another:

Dans la petite ville de P. où j'habite, le mot 'astronome' est à peu près synonyme de tête fêlée.

The medals of the Society for the year were given to Count de la Baume-Pluvinel and to Prof. S. P. Langley. The Society, which is only a dozen years old, seems in a prosperous condition both financially and scientifically. It appears to treat astronomy from a more popular point of view than the English Society, although its list of members contains names of most eminent representatives of accurate science. We congratulate the Society and M. Flammarion, who is responsible for the appearance of the monthly 'Bulletin.'

THE note in our last number on Prof. Schaeberle's resignation from the Lick Observatory was extracted from 'Popular Astronomy' for May. In the June number of the same publication Prof. Schaeberle corrects the statement by saying:—

My resignation from the Lick Observatory takes effect at the close of the present month, and not one year hence. The Regents of the University of California urged me to withdraw my resignation, and, as you stated, offered me a year's leave of absence with full pay, but I could not accept their kind offer. In justice to Prof. Keeler, I desire to say that had the Regents elected any other man for Director my action would have been exactly the same.

A PROPOS of the note in our last number on weather-prospects for the summer, which, by the way, has been the subject of some correspondence in a morning paper, it may be mentioned that the rainfall record for the past month at Greenwich is only 1.718 inch, whilst the June average is 2.022 inch. On the other hand, the sunshine record is 159.2 hours out of a possible 494.5, which is a rather smaller proportion than is usual for this month. General opinion seems to be that the month has been a wet and gloomy one.

FROM Mr. Swasey's speech at the Astronomical Society, reported in this number, it will be seen that Mr. Brashear, the instrument-maker, has been put in charge of the Allegheny Observatory, of which Prof. Keeler was Director. It will be remembered that Prof. Keeler made it a condition of his stopping at Allegheny that a sum of 200,000 dollars should be supplied to re-equip the Observatory. The citizens made a vigorous response to this, but did not quite succeed in reaching the desired sum. The money subscribed, however, is to be applied to the re-equipment of the Observatory, so that the fitness of a practical instrument-maker as temporary Director is fairly obvious.

WE call attention to the partial eclipse of the Moon which will happen on the evening of July 3. The eclipse is very nearly total, but the circumstances are unfavourable for observation, as the Moon does not rise at Greenwich until half an hour after the first contact with the shadow. A short list of three stars which will be occulted during the eclipse is given in the 'Companion.'

THE Annular Eclipse of the Sun which will happen on July 18 is of little interest except to travellers who will be on the South Pacific Ocean at that date.

ERRATA.—On p. 239 of our June number, line 6, for "Ransome and Simms" read "Ransomes and Sims." Also on the same page the focal length of the Greenwich 26-inch telescope should have been 22·5 feet, instead of 26 feet as given.

We shall be glad to receive any additions or corrections to the list of telescopes.

FROM AN OXFORD NOTE-BOOK.

News comes from the Cape that the 18-inch visual telescope, forming part of Mr. McClean's gift, has been tried with satisfactory results. The photographic telescope must await the better adjustment of the driving-clock; but all has so far gone well with the erection of the instrument, and we may expect even better news presently. It is pleasanter to sympathize with others in prosperity than in adversity, and who shall say it is less important? Hence let us rejoice with Mr. McClean in the approaching completion of his valuable gift, and in the publication of his beautiful star-spectra*, which represent half of a noble survey of the whole sky by one man—the other half is already done and is being prepared for publication. On first glancing at these pictures I was disappointed—they seemed to me poor reproductions. On closer examination, however, it was seen that the detail was all there, and that, in fact, the reproductions were vastly better, from a scientific standpoint, than many much better-looking reproductions of spectra. Perhaps others may have shared the former experience without having had time or opportunity to proceed to the latter; and if so this hint may be useful.

* "Comparative Photographic Spectra of Stars to the $3\frac{1}{2}$ Magnitude," by Frank McClean, F.R.S. (Phil. Trans. 1898.)
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SPEAKING of the Cape reminds me that in his last Report to the R.A.S. Dr. Gill says :—

A new instrument for measuring photographic plates, devised by H.M. Astronomer, has just been received from Messrs. Repsold. The new apparatus and methods promise to give even greater rapidity of work than Professor Turner's method, without sacrifice of the accuracy obtained with the older form of the filar micrometer. A description of the instrument, with examples of its work, will be communicated to the Society.

We are all rather anxious to hear more of this new instrument, though we can readily understand that Dr. Gill's hands are very full just now. I don't know on what figures the rapidity of measurement by the method in use at Oxford is based; but it seems fair to assume that they belong to the early history of the method. Thinking that it might interest Dr. Gill to have later ones, I enquired at the University Observatory, and found that a measurer of one or two years' experience can measure and record (unaided) more than 600 stars in a morning of 4 hours (two coordinates and diameter of disc), though this is working under pressure, of course. The accuracy is such that though the probable error of a single measure slightly exceeds $\pm 0''.20$, that of the mean of two is distinctly less than this limit (assigned by the Comité Permanent); and since it is practically imperative to make two measures (for detection of mistakes and elimination of personality), nothing is lost by the increased rapidity.

SELDOM has a man with only a few minutes at his disposal had so much to say as had Mr. Swasey when called upon just before the close of the June R.A.S. meeting. That the big telescope at Allegheny is to be completed under Mr. Brashear's Directorship; that the Yerkes telescope works so smoothly that Prof. Barnard can manipulate it alone (although it was designed for an observer and an assistant); that he, Prof. Barnard, is on his way to Flagstaff to compare notes on the spot with the observers at the Lowell Observatory on planetary detail; and that Messrs. Warner and Swasey are within sight of their goal in dividing a circle to 1"—any one of these four items of news was enough to ensure a welcome. It is invidious to select; but I have little doubt that the third item is of greatest, and at any rate of widest, interest. Mr. Lowell and Mr. Douglass see detail on the planets which others, including Prof. Barnard, do not see. The reason may be found in climatic conditions or elsewhere. In response to an invitation (which was doubtless a special one in his case, but which Mr. Lowell has, with characteristic cordiality, on several occasions made to astronomers generally), Prof. Barnard is going to Flagstaff to try and clear up the discrepancy; and, whatever may be the outcome, we must all admire the good faith and eager-

ness for the truth which prompted the invitation, and the courage which is evinced in the response to it.

A COPY of the 'British Central Africa Gazette' (published at Zomba, price threepence) for 1898, April 30, was kindly sent the other day to the "Senior Professor of Astronomy, Oxford University," with marks drawing attention to an article on the Angoni Zulus, who are just now making themselves interesting. There are, indeed, two articles relating to them, in the first of which are detailed the thrilling adventures of two Europeans who ventured into Angoni-land, and only just managed to get back. We read of one gentleman that he "was unarmed and met a party of 200 armed men on his way, and only escaped by seizing a spear from an Angoni, and threatening the first man who touched him with death." This seems a good plan of action in such emergencies, and it is odd that it is not in greater favour. But it is the second article, being the account of an interview with several Angoni headmen who were visiting Zomba, to which attention is more particularly directed; for the interviewer has managed to get at some valuable facts about time and rain-making.

Why does the Sun set? So that the Moon may come along in turn.

Do you suppose there is some connection between them? They both travel along the same path.

Have the Angoni a Rain-maker? There is a woman who can make rain.

Is this lady married? Yes.

Does the husband also make rain? He does not know the business.

Do they live together? They live together during the dry season, but live apart during the rains.

Why? Her house is full of snakes and ingredients for making medicine during the rains, and no would dare to go there but herself.

Can she stop rain when there is too much of it? Yes, she ties a strip of white calico round her head, and it stops at once.

Does it not happen occasionally that she can't bring the rain on the very day she tries? No, she always brings it; but sometimes the rain is no good for crops. If the rain has this defect she admits it, and owns it cannot be made more refreshing to the soil.

If one person wanted dry weather and another wanted rain would it not be awkward? She can arrange it for each.

Do the Angoni worship or show any respect to the Sun or Moon? No.

What do they think of eclipses? They have not noticed such a thing. (This question was put to several Angoni, but the answer was always emphatically a negative: they had never observed or heard tell of an eclipse.)

AT a recent *soirée* Captain Noble exhibited a curiosity in beer-mugs, hailing from Germany. The pattern was made up of the backs of astronomical books, tastefully bound, and mostly ancient: Archimedes, Copernicus, Galileo, Kepler, and Laplace. Each has his volume in the pattern: Gauss has a good fat one, and Leibnitz two; and a little corner is kept even for Newton, who is repre-

sented by a small 'Arithmetica Universalis.' It makes a very fine mug, and I admired it so much that I asked a well-known "universal provider" whether he could get me one; and this has done, after vainly trying to put me off with similar mugs dealing with Law, Theology, and Architecture, which he said were the "nearest he could get." I hope Captain Noble will not think I have infringed his patent.

THE Astronomer Royal is occasionally appealed to for the time of sunrise or sunset, which may be important in cases of poaching or burglary. These offences change their legal character at sunrise and sunset, in some way which I will not venture to state; but the general effect is that you may commit a more serious crime than you intend if your watch is not right, or if you have not correctly calculated the hour of sunset: and to complicate things further there is the difference between Greenwich and Local Time. It seems late in the century to find that this last factor is an uncertain one; but a recent case, not about burgling but about cycling, seems to point to this curious conclusion. A gentleman was summoned at Altrincham for riding at 8.40 P.M., on April 3, without a light:—

Defendant pointed out that he was within the hours. The Sun set about sixteen minutes later at Bowdon and Manchester than Greenwich, and the more westerly and northerly a town was situated the later the Sun set. It was impossible for two places to have the same sunset owing to the inclination of the Earth's axis. The Bench found there were no "cases" on the point, and dismissed the summons.—*Manchester Courier*, May 17.

TALKING of bicycles there is a little problem in mechanics which I got from a friend not long ago, which I have invariably found a success when propounded to cyclists. Suppose a bicycle at rest with one pedal in its lowest position: take hold of this pedal and pull it backwards; which way will the bicycle move? The answer is most easily obtained, of course, by trial; and hence the unwonted appearance in an Oxford Common Room, not long ago, of a bicycle, which had been brought in to settle the question after a long and vigorous theoretical discussion.

Perhaps I may add the problem which was set to me in return. If n competitors enter for a lawn-tennis tournament, how many games must be played before the winner is found? As expected, I replied at once that I should want to know something about the nearest power of 2; and then it was pointed out that this was immaterial, for since each game knocked out one man, there must be $n-1$ games to find the winner.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

AUGUST, 1898.

No. 269.

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE concluding Meeting of the eighth Session of the British Astronomical Association was held on Wednesday, the 29th June, at Sion College, *Mr. N. E. Green*, President, in the Chair.

Two new Members were elected, and the names of eight Candidates for Membership were read and suspended.

Mr. E. W. Maunder said that the Eclipse Committee were very anxious to publish a worthy and well-illustrated report of their very successful expedition, but they did not feel justified in recommending to the Council that their Report should be published at the expense of the Association, and the Council took quite the same view. It was therefore proposed to issue it as a separate publication at the published price of 5s., but Members who subscribed in advance would receive it at half price. The extent to which it would be illustrated would depend largely upon the number of subscriptions received. The Association did not desire to make any profit upon it. It would be issued uniform with the publications of the Association, but as a volume bound in cloth, not in paper covers.

Mr. Maunder then stated that a communication had been received from Mr. Henry Bessemer, the eldest son of the late Sir Henry Bessemer, stating that his father had desired in his will that his observatory should be placed at the disposal of some public body likely to make use of it, and he therefore now offered it to the Association. It was a large, handsome, thoroughly well-appointed, and most solidly-constructed building. The dome was 36 feet clear internal diameter; the telescope, a reflector of 40-in. aperture, was mounted as an altazimuth. The telescope, the dome, and the floor were all moved by hydraulic power, the motions of the two latter being controlled by the telescope. The eyepiece was in one of the trunnions, so that the observer simply stood on the floor and looked straight before him. As the observatory

stood on the south side of the crest of Denmark Hill, it had a very fine horizon towards the south.

The President said the main question was one of finance. He was informed that £300 a year would be required to keep it in order and take care of it, and that was a sum quite beyond the present resources of the Association. They were, nevertheless, very grateful for the generous offer.

Mr. Maw did not think the offer was one they could possibly accept without considerable assistance, but suggested that if some public body would provide the necessary funds for the care and maintenance of the instrument and building, the Association might, by rendering professional assistance in the management, secure some advantages for its own Members.

Mr. Holmes enquired the exact nature of the offer.

Mr. Maw replied that the land belonged to Dulwich College. The lease had 17 years still to run, during which they would have the building rent-free. After that time they would have to make their own arrangements with Dulwich College.

Mr. Schooling suggested that the large telescope might be used for exhibition purposes, while room might be found for one or two smaller instruments with which original work might be done.

The list of Members nominated for election to the Council for the ninth Session was read. Mr. Henry Ellis and Mr. Gordon W. Miller were elected Auditors, and Messrs. A. J. S. Adams, Frederick Finch, and Augustus Wheeler were nominated Scrutineers of the Ballot.

Mr. Maunder read a paper on the "Oldest Astronomy." He pointed out that the 48 constellations preserved to us by Aratus and Ptolemy clearly had their origin at a much earlier date. They left part of the southern heavens unmapped, and the centre of this blank space must have been the south celestial pole of that time. We deduce from this that these old astronomers lived in N. lat. 40°, and nearly 3000 years before Christ. Possibly, however, some of these constellations were mapped out earlier still, say 6200 years ago, when the spring colure ran between Gemini and Taurus, and the summer colure ran between Virgo and Leo, and perhaps the man-headed bulls of Assyria and the Sphinx of Egypt were composite figures meant to recall these astronomical relations. But the constellations are certainly close on 5000 years old, and were mapped long before the spring equinox entered Aries, disproving all theories of the origin of the constellations which suppose Aries to have been the first sign of the zodiac. It followed also that astrology was not the primitive form of astronomy, but a relatively late superstition.

Mr. Maunder also suggested that the Assyrian "ring with wings," the symbol of the Divine Presence, was really a representation of the corona at sun-spot minimum.

Mr. Crommelin said that Mr. Proctor in his 'Myths and Marvels of Astronomy,' obtained, in the same way as Mr. Maunder did, the

Period of about 2200 B.C., and he pointed out that that was probably the period when the Great Pyramid was oriented, assuming that it was oriented by α Draconis, the Pole-star of that date. He had been greatly interested in that part of Mr. Maunder's paper in which he went right back to 6200 years ago, and in the way he explained the three or four remarkable combination symbols of the ancients by the epoch when the principal points of the ecliptic were just on the limits of the two corresponding signs.

Mrs. Maunder remarked that in a book published a year or two ago by Brennand on Hindoo Astronomy the writer gave various dates for Aryan migrations. He fixed very accurately the Chinese migration as 2757 B.C., and he mentioned that the sign Draco was then the polar constellation, and he argued from that that it was then the Chinese Empire gained its ascendancy, since the sign of the royal house in China was a dragon. Shortly after reading this book the speaker met a Chinese who was a mathematician and astronomer, and took the opportunity of asking his opinion on the point. He replied that the suggestion was not a probable one, as the royal Chinese emblem was of very much later date.

Mr. Chambers said that at a previous Meeting of the Association he had made a few desultory remarks with regard to the forthcoming eclipse of May 1900. As the matter had attracted more attention than he had anticipated, he thought it might be interesting if he went into the subject in a more business-like way. He would first throw on the screen slides representing maps of the paths of the eclipse shadow across both America and Spain. He proposed, however, to deal only with the European track. The line of totality entered Portugal in lat. $40^{\circ} 50'$, long. $8^{\circ} 38' W$. At the town of Ovar the total duration would be 1 min. $33\frac{1}{2}$ sec., and the Sun's altitude at totality would be 42° . At Talavera, in Spain, the duration would be only 1 min. $27\frac{1}{2}$ sec. at an altitude of about 39° , and at Alicante the duration would be 1 min. 19 sec., and the Sun's altitude 34° . With reference to the accessibility of possible places for observation, he found that the Royal Mail steamers from Southampton to Oporto sailed on Fridays, fortnightly. The voyage took about three days, and the fare was £11. They might go to Oporto and back from Lisbon for a slightly increased fare, or back from Vigo (110 miles north of Oporto) for a slightly reduced fare. There were also the Pacific Steam Navigation Co.'s steamers from Liverpool fortnightly on Thursdays, and the General Steam Navigation Co.'s steamers from London. There was also the alternative of the P. & O. steamer from London to Gibraltar. The Orient steamers also equally served for this route. Coming to railway facilities, there was a through train to Lisbon and Oporto twice a week, so that they could leave London on a Wednesday and get to Oporto some time or other on Friday. The speaker did not, however, advise the railway route, the single first-class express fare being £13 10s., and

£4 10s. extra for sleeping-accommodation. Food and lodging, except in the large towns, were not good, and portable provisions should certainly be taken. In conclusion, he estimated that a very satisfactory and enjoyable trip might be arranged for from £22 to £30 per head.

Mr. Schooling asked whether the roads would permit of cycling there.

Mr. Chambers thought that was quite out of the question.

Mr. Maunder said that, although he had at present no definite information, he believed there would be no difficulty in chartering one, perhaps two, special steamers to convey parties to the coast of either Spain or Portugal, and act as their hotel there, precisely as the 'Norse King' had done to Norway. The chances of fine weather, however, would probably be better in the interior of the country.

A set of six photographs of the late eclipse, taken with an ordinary camera by *Mr. Henry Cousens*, Superintendent of the Archæological Survey of India, was next shown on the screen.

Mr. Crommelin drew attention to the remarkable cometary display of the month. He did not think that in the whole history of astronomy three new comets and two periodical comets had been detected in eight days, as was the case this June. He then referred in detail to the comet discovered at the Lick Observatory by Coddington, to a new one by Perrine, and another observed at the Nice Observatory by Giacobini. Encke's had been seen by *Mr. Tebbutt* at his Windsor Observatory; and finally Wolf's Comet, which was only a small telescopic object this return.

A paper on "The Colours of Jupiter's Belts, &c.," by the *Rev. R. Killip* (read by *Mr. Schooling*), concluded the business of the Meeting, which then adjourned until the last Wednesday in October.

On the Canals of Mars.

MY last observations of Mars have led me to an interpretation of the observed phenomena which explains them in a quite natural manner.

In examining a chart of Mars one is struck by the impression that the network of the canals—which resemble so much a map of triangulation—cannot have been made by Nature; everything leads to the conviction that this network is artificial. The great difficulty, hitherto, has been found in endeavouring to find a reason *why* the supposed inhabitants of Mars should have digged canals of such extraordinary breadth, *how* such a tremendous labour was possible, and how it is that no mountain-chains hindered the straight-lined direction of almost all canals.

The latter question is the easiest to be answered. According to

the theory of Laplace, Mars must be many hundreds of millions of years older than our Earth; besides, being so much smaller, the process of cooling must have gone on much quicker, so that Mars has now reached an age which our Earth will not attain for many hundreds of millions of years. Now we know that upon our Earth the mountains become gradually lower and lower, because their surface is continually dissolved by the air and the dust carried by the wind into the valleys, so that the latter at the same time are continually heightened. Of course this process is going on very slowly, so that even in 1000 years it is scarcely perceptible; but after many hundreds of millions of years the whole process will end in the total disappearance of elevations—the surface of the Earth will be flat like a plain! Mars *has* reached this epoch, and therefore his canals find no obstacles in mountains.

The first two questions can be answered when we remember the Dutch dams or dykes. One knows that the Dutch are obliged to protect their low-levelled country against the sea by dams; if we suppose that the continents upon Mars resemble Holland, it may be presumed that the Martian inhabitants were obliged to protect their shores in similar manner. They have built dams along their coasts, while, at the same time, they have tried to lead the seawater into the interior of the continents by means of waterways and canals. Of course it was not necessary to *dig* these water-streets; it sufficed to erect dams between which the water might run as in a canal. It is obvious that the labour is just the same whether one builds two dams at a distance of 5 yards or of 200 miles. Besides, it is possible that a height of three feet would have sufficed for the purpose. Now we know that gravity upon Mars is but one-third of that upon our Earth; we could, therefore, perform there almost *threefold* labour with the same expenditure of force; and, on the other hand, we have no idea what mechanical means and engines are at the disposal of the Martian inhabitants. Considering the admirable progress mankind made during the last 100 years, so far as inventions and discoveries are concerned, we cannot imagine what inventions and discoveries will not be made within the next hundred million years.

One sees that, under such suppositions, the work itself of the Martian canals would be no impossibility. The reason *why* the canals are so broad is also easily explained. At the great distance of the planet we see but the largest canals; the millions of lesser ones remain invisible. The purpose of the largest canals is to feed the smaller ones; therefore they must contain water enough, and be very broad—not being deep! It is perhaps less for shipping purposes than for the provision of drinkable water* and water for irrigation, which induced the inhabitants to build these canals, or perhaps *both* purposes.

* It is not of necessity that the Martian seas should be salt; it may be that the organism of the Martian inhabitants requires salt, as do our fishes and the other animals of the seas.

As to the gemination of the canals, I have arrived at the conclusion that this does not exist! What one calls "double canals" are parallel canals which always exist. That is to say, there are many near, parallel-running canals, which sometimes have the appearance of *one single broad canal* (almost *always* to my eyes!), and which sometimes are seen separated. Often one sees but *one* of the two canals, and then one believes it to be single. The reason *why* we do not always see both canals is the same as why we do not see all existing canals at the same time—a fact known to every observer of Mars, and only to be explained by certain qualities or peculiarities of the Martian atmosphere which are unknown to us. My chart, published in the 'Abhandlungen' of the Royal Prussian Academy of Sciences, shows many parallel canals, although I only once thought that I saw both lines at the same time. Nevertheless it is beyond doubt that the parallel canals really exist; not only my own observations, but also those of Schiaparelli and Lowell prove it. For instance, Ganges is a double canal which I saw as such once in 1894; in 1896–97 I always saw it as large as my chart shows it, consequently both canals together gave the impression of one very broad canal; but I had seen it quite as broad before, on 1896 May 20, many months before the epoch at which (according to the common suppositions) the gemination should have begun!

Accepting my new explanation, one can also interpret other phenomena. Repeatedly one observes certain regions (Libya, Hesperia, Electris) totally or partially darkened. This may have been caused by breaking of dams and temporary inundations—as happened also in Holland. The isles and peninsulas of the seas "Australe" and "Erythraenum" seldom show such sharp coast-lines as the continents; this may be explained by the circumstance that, for certain reasons, these regions could not be protected against conditions which sometimes ravage certain parts of them. The circumstance that several canals sometimes resemble broad straits can be explained, too, by assuming a breaking of dams, in consequence of which the surrounding regions are inundated as far as the next parallel dam.

The interior lakes may have the same origin as the Zuyder-Zee in Holland, which is due to an extraordinary breaking of a dam, after which it was impossible to expel the penetrated water, so that the inhabitants were obliged to build new dams in order to hinder a further invasion of the sea. The rectangular form of Trivium Charontis and Propentis seems to be good evidence for this supposition.

The smaller lakes at the crossing points of the canals seem to be intentional "reservoirs" for providing the canals with water. The alleged gemination of such lakes can be explained by the supposition that the lower parts of the lake-bottom (perhaps artificial dams) become prominent when the water-level in the seas

sinks sometimes; that would, of course, make the impression of a gemination.

When a great canal has given too much water to the less ones it must become shallower and consequently fainter in appearance, perhaps invisible to us; as soon as it gets more water from the seas or from a still greater canal, it becomes darker and visible again. In this manner even the temporary fluctuations of intensity would be explained.

The above lines are an abstract of my paper "Resultate aus den Mars-Beobachtungen an der Manora-Steinwarte," published in No. 22 of the Berlin 'Naturwissenschaftliche Wochenschrift,' where I gave detailed outlines of my new hypothesis. The latter explains, as may be seen, all enigmatical phenomena upon Mars in a way quite natural and unforced; it stands in no contradiction with the observations, nor is it based upon impossible suppositions. And more than this must not be demanded of an hypothesis.

LEO BRENNER.

Almanacs.

To state accurately what an almanac is would be a strain even on the proverbial capacity of the average school-boy. According to his limited experience he would in all probability describe it as something stuffed through the letter-box, containing dismal and gloomy descriptions of terrible diseases we either have, or ought to have, with advertisements of patent medicines destined to cure them all. What examiner would take the responsibility of directly contradicting such a statement? Almanacs and medicines are, at the present day, apparently hopelessly mixed up.

Almanacs, however, beyond being a useful medium for making known the virtues of patent medicines, baking-powders, and cocoa, serve other and, according to some belated persons, more respectable and useful purposes. This is a mere matter of taste.

The meaning of the word may, perhaps, give us some help in forming an idea of what an almanac really is or ought to be; but no one seems to know exactly how the word was built up. Indeed its etymology has given learned doctors about as much trouble as any other word in our language, and it requires the easily-satisfied temperament of a jerry-builder to have faith in the structures which have been presented to us. There is the Arabic particle *al* and the Hebrew *manach*, to count; also Scaliger would persuade us that it comes from *al* and *μαράκος*, a lunar circle; Johnson wants us to accept *al* and *μήν*, a month; Goliush points out that it was customary throughout the East for subjects to make new-year's gifts to their princes, and that the astrologers presented their ephemerides, which hence were called *al-manha*, i. e. the new-year's gifts. The one thing a mere outsider gathers from all this

is that the ground-floor, like the observing-floor at Yerkes, is an easy-going, automatically-adjustable particle. This same Arabic particle will fit any root in any language.

There is one authority who lays claim to our sympathies by throwing over the Arabic universal joint, and, by bringing our own more immediate ancestors into it, establishes a sound reason for placing belief in him. Verstegan says that the Saxons were in the habit of carving the courses of the Moon for the year on squared sticks, about a foot in length; such a stick was called *al-mon-aght*, i. e. *al-mon-heed*, the regard or observation of all the moons. Hence "Almanac." In Chambers's 'Book of Days' it is stated that such a stick is preserved at St. John's College, Cambridge.

Whatever may be thought of these derivations it will probably be agreed that the Almanac itself originated in the East. The belief in astrology made a fairly accurate knowledge of the appearance of the heavens at any given time an absolute necessity. This pretended science has flourished amongst oriental peoples from the earliest times, and we can readily conceive that astronomy was studied for the sake of astrology. This would eventually lead to tabulated results and predictions of phenomena. Agricultural and other items would from time to time be added, and the result would be a collection of astronomical and astrological phenomena, facts, maxims, prophecies, and pretensions, differing little in principle from our own early almanacs, or even from some of the present time.

The ancient Romans had a custom, dating from a very early period, of proclaiming the first of the month by affixing a notice on some public building*: the days of the religious festivals were then known. From the Greek verb *καλέω*, I call or proclaim, this first of the month came to be styled the *Kalendæ* or *Kalends*, and the *Fasti Calendares* became a name for the placard. By natural evolution a book of accounts referring to days was called "*Calendarium*," a calendar, and from this by easy stages to time arrangements generally.

We thus have the complete designation "Almanac," with the subsidiary title "Calendar" referring to the particular portion.

An almanac, seriously considered, may now be defined as an annual publication giving the civil divisions of the year in the form of a table or calendar, in which are set down—

The day of the week for each day of the month.
Moveable and fixed feasts.
Times of rising and setting of the Sun.
Times of rising and setting of the Moon.
The Moon's phases.
Solar and lunar eclipses.
Places of the planets and principal stars.

* The Babylonians and Jews had a similar custom.

Various other astronomical phenomena; time of high water; meteorological notes; agricultural and statistical facts; and numerous other matters dependent on the line along which any particular almanac has been developed.

Those containing special information suitable for astronomical and navigational purposes may be regarded as a distinct species, requiring the most delicate attention, their constitutions being liable to suffer from constant aberrational effects. These are known as "Nautical Almanacs."

Until quite recently the history of almanacs did not take us further back than the early days of the Christian era. Delambre discovered a manuscript by Theon, the commentator on Ptolemy, in which an almanac is described somewhat minutely, thus proving that the Alexandrian Greeks, about 100 years after the commencement of the Christian era, used them. Lalande unearthed an almanac by Solomon Jarchus, dating about A.D. 1150. The Savilian Library at Oxford contains a MS. copy of one issued by Petrus de Dacia about the year 1300. Specimens of manuscript almanacs of later date are fairly numerous.

In 1892 Fathers Strassmeier and Epping published their researches in Assyriology*. Among the cuneiform astronomical texts deciphered by these *savants* are journals of the Babylonian observers during portions of the years 38 and 79 of the Seleucidæan era, or 274 and 233 B.C. From these we learn that calendars for popular use were issued, containing the more remarkable circumstances of a lunation, prediction of eclipses, conjunction and opposition of planets, with heliacal risings and settings. Interspaced amongst astronomical data are observations appertaining to religious, social, and commercial matters.

The introduction of printing naturally gave a great impetus to their growth, and as astrology was also in a fairly flourishing condition, an almanac was indeed a treasure. Still, almanac-makers had their troubles, as Regiomontanus found, for in the manuscript works it was the custom to mark the Saints' days in *red*, and in red they still had to be marked in printed editions, for, as De Morgan remarks, "our ancestors were a jealous race and would not have kept a Saint's day if it had not been marked in red," and when Regiomontanus started to print the first almanac about 1472 or 1473, at Nuremberg, he had to meet the difficulty by having all the red parts marked in afterwards by a pen. This work was for the three years 1475, 1494, and 1513, and its form is very much that of the present-day almanac. It has 64 pages, each month occupying one opening, displaying in columns the succession of days, the dominical letter, Saints' days (in a broad column), Moon's mean and true longitude, phases of the Moon for all 57 years of the three meteoric cycles, *i. e.* from 1475 to 1531, both inclusive.

After the monthly pages comes a table of the latitudes and

* 'The Observatory,' vol. xv. p. 327.

longitudes of the chief places in Europe, not very accurate but interesting. It seems to have been the custom to arrange the longitudes according to the place of printing: hence Nuremberg is set down in longitude $0^h 0^m$. After this table come eclipses visible at Nuremberg, tables of the lengths of days, description of a horizontal sun-dial, &c. Only one page is devoted to Astrology, but Regiomontanus makes up for this by promising to write a treatise: evidence, then, that the first printed almanac was due to an astrologer.

The most interesting almanac, however, of this early period is by Stöfler, and the legend attached to Stöfler himself is admirably adapted to illustrate the growth of historical facts and their barnacle-like attachment of untruth. The following is abridged from De Morgan:—Regiomontanus was one of those who could assign a date to the end of the world by observing the heavens, and Stöfler is famous for the deluge which he *did not* predict. That the world was to be destroyed by a deluge in 1524 certainly was announced, and it caused great fright; people living near the sea or a river left their homes. Many learned treatises were written against the prophecy, and every author referred to Stöfler as the evil prophet. History, then, is unanimous against him, and it added an account of his death which seemed to point him out still more decidedly as an unlucky prophet. The stars told him that on a certain day he would be killed by something falling on his head. In order to circumvent fate he determined not to quit his house that day, compensating himself by inviting some friends to dine. But an argument arose at dinner which obliged him to go for a book to settle it. The bookcase was badly secured, and tumbled with all its contents upon him, to the entire fulfilment of his destiny. This story, fairly attested, joined to the fact of his being an astrologer, gave tolerable corroboration to the great mass of authority which pointed him out as the predictor of the deluge.

De Morgan could find no such prophecy in any of Stöfler's works, and the truth appears as follows:—From his ephemeris, which astrologers would naturally prefer to all others, both as the work of a decided believer and as intentionally adapted for their pursuit, the users would find that in February 1524 three planets would be in conjunction in the watery sign of Pisces. This, as one may easily see, would be enough to drown a globe 50 times as big as ours if there be anything in astrology. This deduction would be noised abroad as being derived from Stöfler's ephemeris, and ultimately he would get the credit of the prophecy.

Stöfler's almanac is more complete than that of Regiomontanus and contains several interesting features. De Morgan points out that in the drawing of the zodiac the Twins are usually represented in some brotherly relation to one another; but here a significant hint is given of the state of the times. One of the Twins has his hand on the throat of his brother and has forced him to the ground, the suffering person holding in his hand a large key, the

emblem of the church. Stöffler's almanac was published in 1518. Luther protested against indulgencies in 1517, and in 1518 the Elector of Saxony made his first interference in Luther's favour. At the bottom of the calendar pages are pictures descriptive of the agricultural occupations in the several months, with a Latin couplet to each all pointing to jolly times, *e. g.* :—

November.—I sell the fat goose to the rich and cut down wood at the proper time of the Moon.

December.—Now I will live a jolly life, for I will kill the sow in triumph.

Up to 1497 the printed almanacs used in England came from Holland, and as they were on small folio sheets they have been preserved, from having been pasted within the covers of old books. In 1497 the 'Sheapheard's Kalendar' * was published, and is probably the first almanac printed in England. It is really a translation from the French by Richard Pynsen. Here, as on the continent, almanacs were a mixture of astronomy and astrology, with perhaps more of the latter; but the most skilful mathematicians were engaged in their compilation.

Leonard Digges, born in Kent in 1524 and educated at Oxford, issued in 1553 a sort of almanac entitled 'A Prognostication everlasting of Right Good Effect, fructfully augmented by the Author, containing Plaine, Briefe, Pleasant, Chosen Rules, to judge the Weather by the Sunne, Moon, Starres, Comets, Rainbow, Thunder, Clowdes, with other Extraordinary Tokens, not omitting the Aspects of the Planets, with a Briefe Judgement for ever, of Plentie, Lacke, Sicknes, Dearth, Warres, &c.'" Amongst other lucubrations in this book is the following :—

What Meteorologer consenteth not to the great alteration and mutation of Air at the conjunction, opposition, and quadrant Aspect of Saturn with either two lights? Who is ignorant, though poorly skilled in Astronomy, that Jupiter, with Mercury or with the Sun, enforces rage of winds? What is he that perceives not the fearful thunders, lightnings, and rains at the meeting of Mars and Venus, or Jupiter and Mars? Desist, for shame, to appugn these judgements so strongly authorized. All truth, all experience, a multitude of infallible grounded rules, are against him.

Digges was a nice, quiet, inoffensive country gentleman, and not so ambitious or clever as his contemporary Dr. Dee, Fellow of Trinity College, Cambridge. His leaning towards the "Black Art" procured for him a fairly brisk time in travelling hurriedly to the continent. On one occasion, shortly after the accession of Queen Mary, he found himself in a tight place. He was accused of "practising against the Queen's life by enchantment," and only wriggled out of the difficulty after many sad experiences. However, on the accession of Elizabeth he was consulted by Lord Dudley respecting "a propitious day" for the coronation. Besides being the author of an almanac he was the writer of many astrological and other books.

* This title was borrowed by Spenser the poet for his first pastoral, published in 1576.

Almanacs about this time obtained such a hold on the credulity of folk, and caused so much mischief, that Henry III. of France in 1579 prudently decreed that "no almanac-maker should presume to give predictions relating to civil affairs, either of state or private persons." Whether owing to the more phlegmatic temperament of our forefathers, or other more occult cause, it was not found necessary to stop down the imaginations of the English almanac-makers. Still they did not escape Royal notice. James I. was utterly incapable of allowing so good a chance of creating a monopoly to slip: accordingly he granted a monopoly of the trade in almanacs to the Universities and the Stationers' Company. Oxford and Cambridge took no active part in what followed, their rôle consisted merely in receiving an annuity from the Company to forego their share and keep fairly quiet. Under the auspices of the Stationers' Company almanacs flourished mightily, and the trade seems to have been in a good condition. We read that the astrologers formed themselves into a Company and enjoyed an Annual Dinner.

The Company evidently were not anxious to restrict almanacs to astrological uses; their action appears to have been to supply any demand, whether of the credulous or sceptical, provided there was money in it. For even in 1624 they issued the usual astrological predictions in one almanac and an undisguised contempt for them in another. Thus Alstree's Almanac for 1624 has the following doggrel:—

Let every philomathy*
Leave lying astrology;
And write true astronomy,
And I'll bear you company.

All writers agree in declaring that the period during the civil wars of Charles I. was the real palmy time, and they also are unanimous in ascribing the premier position to Lilly. This celebrated, or rather notorious, character was born in 1602, and at the age of 30 studied astrology under Evans, a clergyman who had been expelled his curacy. He attained great celebrity, and in 1634 we find him engaged with mosaical or miner's rods searching for hidden treasure with Davy Ramsey, His Majesty's clockmaker, in the cloisters of Westminster Abbey: the Dean was to go halves. A few lead coffins were turned out, and things seemed to be going smoothly when a thunder-storm arose, which so frightened the astrologers that they incontinently took to their heels and made a strategetic movement homewards. Ten years after this inglorious feat he issued his first almanac under the title of 'Merlinus Anglicus Junior,' and such was the avidity with which the people received his prognostications that the whole edition was sold in a few days, notwithstanding the "mutilation the work had suffered from the licenser of mathematical works." Aubrey, evidently an

* Referring to the mathematicians employed in compiling the almanacs.

infidel, declares that "most of Lilly's hieroglyphics were stolen from old monkish documents. Moor, the almanac-maker, stole from him, and, doubtless, some future almanac-maker will steal from Moor." Lilly's politics would shed lustre on the Vicar of Bray.

We are not to suppose that all was plain sailing for the astrologers and almanac-makers. As early as 1609 Thomas Decker, a dramatic author, girded at them in his '*Raven's Almanac*,' wherein he foretells a Plague, Famine, and Civil War. He facetiously dedicated it "To the Lyons of the Wood, to the Wilde Buckes of the Forest, to the Harts of the Field, and to the whole country that are brought up wisely to prove Guls, and are born rich to dye Beggars."

Even the Company of Stationers published an almanac for scoffers and sceptics. '*Poor Robin*' came into existence in 1663, and it lashed out valiantly. It is described as "*An Almanac after a new Fashion, wherein the Reader may see (if he be not blinde) many remarkable things worthy of Observation, containing a two-fold Kalendar, viz.: the Julian or English, and the Roundhead or Fanatic.*" As a specimen of its humour we are told, under January, "there will be much frost and cold weather in Greenland." Under February, "we may expect some showers of rain this month, or the next, or the next after that, or else we shall have a very dry spring." Robert Herrick is said to have helped in compiling the earlier numbers.

In 1664 John Evelyn published his '*Kalendarium Hortense*,' the first Gardener's Almanac, wherein is contained the sage maxim, namely, that every man ought for his health's sake to take a country walk of a mile every morning before breakfast—and, if possible, *let it be on your own ground.*

T. LEWIS.

[To be continued.]

The End of an Observatory.*

AFTER the rupture of friendly relations between the French and Malagasy Governments in the island of Madagascar in October 1895, and French colonists and missionaries were ordered to leave Tananarivo, the Bishop asked the Prime Minister to take under his protection the Observatory of Ambohidempona, which belonged to the Catholic Mission. This he promised to do, and the two native assistants received orders to continue the series of meteorological observations which had been in progress since 1889.

For nine months nothing occurred to break the tranquil routine, when suddenly a rumour arose which disturbed the peaceful in-

* A free and abbreviated translation of an account under the same title by Le Père E. Colin, S.J.

habitants of the neighbourhood. An Indian, an English subject, affirmed that there were materials of war in the Observatory, hidden there by the French before they left. "A battery," said he, "and bombs." Forgetting to add, even if he knew, that the battery under the Observatory floor was composed of harmless Leclanché cells, and that the apparent bombs were merely stores of the satisfying sausage, hung to dry on the rafters.

But with the French army approaching Tananarivo, one could not listen to such explanations as these. On 1896 August 2 the Hova Government deputed an Inspector, Ramarosaona by name, to enquire into the state of things at the Observatory. The Inspector, seizing his opportunity, made discoveries! Discovery number one—six boxes marked *Produits chimiques et photographiques*. "Ah, ha!" said he, "here is dynamite." Discovery number two—two long copper tubes mounted with brass and glass. "Ho, ho!" he added, "evidently the latest thing in guns"; and assuring himself that his energy cannot pass unrewarded, hastens with his prizes to report to the minister, Rainilaiariny.

But the interview did not take quite the turn the Inspector wished. One of the Assistants, Robert by name, who had witnessed these momentous discoveries, followed to the official quarters, and when the minister, who at once understood that the suspicious objects were not cannon but telescopes, questioned him as to his work, Robert was able to convince him that it was of quite a pacific nature. "Very good," said the Minister, "but these telescopes are just the things for us to observe military signals with. Leave them here. The Queen wants them."

Not only these did the Queen want, but more, and next day Ramarosaona was sent to the Observatory to forage for telescopes. The first that took his fancy was the one with which the scale of the anemometer was read. This was taken for military purposes, so that the luckless observers had now to risk their necks by climbing to the top of the dome to read the velocity of the wind. But this did not satisfy the Inspector. "Any more telescopes?" said he. "O, yes!" said the cynical Robert, "there is the meridian circle. The soldiers will be able to tell the time by that. And the great equatorial. The pillar of that is just the thing for a baggage-wagon." Ramarosaona, however, did not accept these well-meant offers, but departed. A few days later the Observatory had to receive the unwelcome attentions of a thousand Hova soldiers camped in the neighbourhood, who not only cut the branches from the trees, dug up the potatoes, and destroyed the gardens, but also stole a Richard thermograph, three earth thermometers, and a pluviometer. The last-named article was converted by the pillager into a rice saucepan.

Then there came another thief. In the midst of his troubles Robert solaced himself by playing his harmonium. The Queen's nephew, Prince Rakotomena, being in the neighbourhood and hearing music, was seized with the idea that he would like to

play on a French instrument. Robert received orders to hand over the harmonium *that the Prince might protect it against thieves.*

Matters did not stop here. That story about the battery, and the bombs, and the six cases of dynamite was not yet laid to rest. One fine morning a large and distinguished party of high officials presented themselves at the Observatory to make an examination, which they did at considerable personal inconvenience. Picture to yourselves a Minister of State for Foreign Affairs stretched on his stomach with a guttering candle in his hand among the dust and the slugs in the narrow space between the joists of the Observatory floor. Never mind; he found the Leclanche cells, and the wires, and the deadly crystals of sal-ammoniac, all of which were sent, with the now famous six suspected cases, to the Queen's Palace, and on the morrow all Tananarivo was talking of the fearful discoveries made at the Observatory. As soon as the cases were opened and their contents examined it was realized that these were not actually of a dangerous nature; but still the Government were loth to believe that there were no secret stores at the Observatory, and so they sent a fifth person to explore. This man, after receiving the most solemn assurances from the Assistants that they had nothing which they need conceal, and after careful examination, satisfied himself of the innocence of the institution.

And then the Hova Government felt furious at having been so befooled, and in revenge resolved on the destruction of the Observatory. The exact terms of the order issued by the Queen ran:—"The Observatory will be pulled down, in order that the French, as they approach the capital, may not find a single lodging." How inadequately this purpose was fulfilled will be seen later. On hearing of the order, Robert, scarcely able to credit it, went to the Minister for confirmation, which unhappily he received; he and his colleague then made efforts, in which they were partly successful, to dismount the astronomical instruments and deposit them in a place of safety. One cannot think too highly of the conduct of these two faithful Assistants under such trying circumstances. It is worthy of record that the meteorological observations were continued even to the moment when the work of demolition began. Another character on the scene, whose endeavours to save the hapless Observatory deserve recognition, was the daughter-in-law of the Prime Minister, devoted to the French cause, who warned Robert of the approaching destruction, and placed her house at his disposal to receive the threatened instruments.

Then happened a destruction such has fortunately never been before seen in an observatory. The black natives, armed with iron bars, axes, and hammers, attacked the domes, the sheds, the magnetic pavilion, and such smaller structures as were more readily destroyed. They stole the rollers of the domes, the remaining meteorological instruments, a chronometer, a magneto-

graph, and a sidereal clock, which was judged of little value because it did not show correct time, and was at once deprived of the mercury in its pendulum. Then the crowd adopted more violent measures, and sunk a mine to blow up the brick pier of the great equatorial, 8 metres high. This scheme, however, failed, as the powder refused to explode, and finally the order was given for the destroying band to quit the scene, which they did, leaving behind them a ruin complete and unrecognizable.

The next part of the history of this building is remarkable. The Observatory was turned into a fortress; its position rendered it a strategic point of the greatest importance, so that the Malagasy established there a fort which the French officers saw at once it was to their interest to take. The consequent bombardment still further destroyed the walls which were standing, but eventually the French took possession, and from this point of vantage brought their artillery to bear with great effect on the Queen's Palace and the Capital, and the fire from the Observatory precincts was not a small part of the cause that led to the surrender. After the capitulation the French officers took stock of the damage done, and took care that, so far as was possible, the instruments which had been removed should be returned; but, as may easily be believed, there was much missing and many damages. Robert's harmonium was returned to him with two keys broken and with a hole in the bellows. The standard clock had been sold, and the thief restored 150 francs in its place; in short the greater part of the booty remained in the hands of the plunderers.

So ends, for the moment, the Tananarivo Observatory, after a successful career of six years and seven months. From its ashes it is hoped that a new observatory will arise. Father Colin, the original Founder and Director, returned to Madagascar to take part in a topographical survey, and to restore, if possible, the institution of which he was so cruelly deprived. He has an assurance from an officer in high place that as the Hovas destroyed the Observatory, so will they rebuild it.

The Spectroscope in Eclipse Work.

THERE is often a fashion in astronomical instruments as well as in things more mundane. Some able observer will work out a form to suit his own purposes, and accomplish much by its use; but no one else at once follows in his steps. His instrument falls then into disuse, but ere long some other astronomer arises who finds the now discredited weapon just what he needs, and it comes into vogue a second time. Of such vicissitudes the "object-glass prism," or as, when employed for photographic registration, it is now commonly called, the "prismatic camera," offers a good example. Used by Fraunhofer in the earliest days of "celestial

chemistry," for his grand pioneer work, temporarily revived by Secchi and Respighi, it met with almost total neglect until Pickering applied it to stellar spectrography. Here its magnificent success inaugurated quite a new era in our study of stellar physics. And now most recently of all Lockyer has applied it again to solar eclipse work, and it has proved itself in that connection by far the most powerful of all our weapons of research.

Its simplicity of structure gives it the initial advantage of great economy of light. It has a further enormous advantage over the slit spectroscope in grasping the phenomenon of an eclipse in its entirety; it is not restricted to the exiguous slice included between the jaws of a slit. It escapes the confusion caused in the slit spectrum by diffused and scattered light. It chronicles in minutest detail the distribution over chromosphere, prominences, and corona of the gases represented by the bright lines of the spectrum. It is, indeed, not theoretically suitable for the determination of wave-lengths, but, practically, little uncertainty attaches to its use for this purpose. It is possible, by giving a suitable inclination to the plate, to obtain a practically perfect focus throughout the entire range of the spectrum—an impossibility in the slit spectroscope, unless used with an absolutely achromatic light-gatherer, as, *e. g.*, a reflector. It has but one important drawback; it does not differentiate between a real irregularity of shape in a prominence and an apparent deformation due to motion in the line of sight.

Whenever, therefore, there is a question of which form of spectroscope is to be used in an eclipse, and circumstances forbid more than one being employed, there can be no question that the prismatic camera has the first claim. The slit spectroscope may well be brought forward as a subsidiary weapon of attack. Displacement work is its speciality; its use in wave-length determination is more direct than the prismatic camera, and in the clearing-up of one of the most difficult and delicate of eclipse enquiries,—whether a particular gas exists only at a given height above the Sun, or extends from that height right down to its surface—it is of service for presenting the evidence in a somewhat different form. Employed without a primary telescope or condensing-lens to form an image on the slit—as an integrating spectroscope, that is to say—it is useful as registering not the relative intensity of particular rays, but their relative total light, a most important additional information.

Beside these three forms—the prismatic camera; the slit spectroscope used with a telescope as an analyzer; the slit spectroscope used without a telescope as an integrator—there is a fourth form, an analyzing spectroscope used without a slit, the image of the eclipse being formed in the common focus of the condensing telescope and collimator. This gives a spectrum like that of the prismatic camera in form, and though not so economical of light, and only giving a true focus for a limited range of rays, has an occasional field of usefulness.

The chief interest of the spectroscopic results from the recent and preceding eclipses attaches to the spectrum of the "flash," the beautiful phenomenon shown just at the beginning of totality, when the rapidly narrowing strip of continuous spectrum is invaded by a constellation of bright points, which shine for a moment as a crowded series of bright little coloured arcs after the continuous spectrum has gone, and disappear in their turn a second and a half or so later. The same phenomenon, but in the opposite order, is seen, of course, at the end of totality.

There is no doubt as to the meaning of this short-lived, but most beautiful spectacle. It represents a region of glowing gases extending to a height of about 700 miles above the solar surface. That much is clear; the debateable point is the relation of these gases to the dark lines which we find in the spectrum of the solar disk.

Until recently most astronomers have been content to follow the opinion of the first observer of the "flash," Prof. Young, who considered that these innumerable bright lines corresponded substantially to the Fraunhofer lines, and were in effect their reversal, and the "flash" has often been spoken of in consequence as the spectrum of "the reversing layer."

Lockyer, however, has called this conclusion in question, and gives it as his opinion that there is no "reversing layer" at all in the strict sense of the word, but that the absorption of which the Fraunhofer lines are the evidence takes place at a variety of levels above the solar surface, and that the Fraunhofer spectrum is the integration of the absorption exercised by a great number of distinct strata.

This opinion is intimately connected with his theory that the majority of the terrestrial elements which we recognize in the Sun are dissociated at the temperature of the photosphere. The two rival theories are indicated by him in his 'Chemistry of the Heavens,' Chap. XXII., with admirable clearness. The old view affirms the existence of terrestrial elements in the Sun's atmosphere, and their thinning out in the order of vapour-density as we rise above the surface, all being represented in the lowest strata, which, as the regions where the absorption giving rise to the Fraunhofer lines chiefly takes place, may aptly be called "the reversing layer." Lockyer's hypothesis assumes the terrestrial elements, in the main, to exist only in the higher, cooler regions of the Sun's atmosphere; which atmosphere is not composed of substances which thin out as we recede from the Sun, but "of true strata, like the skins of an onion, each different in composition from the one either above or below," and in the lower strata "we have not elementary substances of high atomic weight, but those constituents of the elementary bodies which can resist the greater heat of these regions."

It is clear that the two views allow of some latitude of definition. No one ever supposed that the whole of the Fraunhofer

absorption took place within the 700 miles depth of the "flash" to the absolute exclusion of all other strata. Under both hypotheses, under any hypothesis, the Fraunhofer lines are the integration of the effect of *all* the strata through which we look at the Sun. But the composition of the strata is a different matter; and the old and Lockyerian theories turn on the question whether the successive strata are simply functions of the "thinning-out" process, or are of actually different composition.

Here comes in the immense value of the negatives of the spectrum of the "flash." They give us clearly and distinctly the spectra of the various regions of the solar atmosphere, the height attained by any bright line being clearly indicated in three distinct ways—by the angular extension of the arc over which it is traced, by the height required in a lunar mountain to cover it, and by the time the Moon's limb takes to blot it out. But the answer to the question, "does this particular line represent a gas existing at this height alone, or one extending from this height right down to the photosphere?" is one which only the most minute and detailed examination of each line will answer, and not by any means always clearly then.

But there is one way in which we can easily distinguish between the two theories. In both the Fraunhofer spectrum is the integration of the absorption of all the strata through which we look at the photosphere. But on the old view the main absorption takes place in the lowest strata; they most nearly correspond to the total effect; they form what may be fairly, if a little inexact, called the "reversing layer." In Lockyer's view the exactly opposite condition prevails. In the lowest strata we have a few intensely-heated primary gases, by analogy giving, in all probability, spectra of extreme simplicity, and hardly entering into the composition of the Fraunhofer spectrum at all—gases, like helium, for which the emission balances the absorption. But in the highest strata we find these primary gases entering into combination with each other to form numerous secondary substances of more complicated spectra, lower temperature, and greater absorption. Just as, on the older hypothesis, the lower we go the nearer we get to a complete representation of the Fraunhofer spectrum, and we find the closest approximation to a "reversing layer" at the base of the solar atmosphere; so on Lockyer's view the higher we go the nearer we get to that complete representation and we find our "reversing layer" at the summit of the solar atmosphere. In Lockyer's own words on the old hypothesis, "the spectrum of the base of the solar atmosphere should most resemble the ordinary Fraunhofer spectrum"; on the new hypothesis, "the spectrum of the base should least resemble the Fraunhofer spectrum."

Of course, though our instrumental limitations oblige us to treat the whole of the 700 miles depth of the "flash" as a unity, it is clear that it must cover a most enormous range of temperature,

pressure, and constitution. We cannot, on either hypothesis, push our way right down to the true basal stratum of the Sun's atmosphere. All we can do, then, with our spectrographs of the "flash," is to ask "Which way does the tendency run?" "Are the lowest strata, so far as we can observe them, most like or least like the Fraunhofer spectrum?" If the first, then the dissociation theory is wrong; if the second, it has established its claim.

There is no question—there can be no question—of obtaining a bright-line spectrum which should correspond to the Fraunhofer spectrum like a positive to a negative. The suggestion that this is the point at issue shows a very crude idea of the conditions of the case. We are obliged, observationally, to treat 700 miles depth of atmosphere at the Sun as an homogeneous integer: but we know it cannot be so in reality. Its lowest seven miles would certainly show much individuality if we could observe their spectrum. And again, we have much to learn about the exact nature of the correspondence between the bright-line spectrum of a gas and of the dark lines which it would show as an absorbing agent. The relative intensities of the dark lines of a given element as seen in the Fraunhofer spectrum show many differences from the relative intensities of the bright lines obtained in our laboratories. This fact has been used as a very sheet-anchor of the dissociation theory, but to resort offhand to such an explanation is to evade enquiry rather than to pursue it. One thing, however, clearly results from the number and character of the splendid spectrographs of the "flash" obtained in the recent eclipse; we are now in a far better position for comparing the spectra of solar and terrestrial substances than we could have been by the study of the Fraunhofer spectrum of the disk itself for years, for we can now bring into comparison the bright line emission spectra of the one with those of the other, uncomplicated by any questions of reversal and absorption.

E. W. MAUNDER.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Solar Parallax and Transits of Mercury.

GENTLEMEN,—

Miss Giberne's excellent little work, 'Radiant Suns,' is undoubtedly the best which has been written to give ordinary readers some insight into the modern science of the physics of astronomy and the marvellous results which have been obtained by the application of the new instruments and methods of research. But, whilst lately reading her chapter on "The Problem of Sun-Distance," I was rather startled at the remark that transits of Mercury have been applied to its determination, in addition to and since those of Venus. I do not think that this

has ever been done; nor, indeed, does it seem worth doing, as the nearest distance of Mercury is more than double that of Venus (so that its parallax is less than the difference between it and that of the Sun), and not only considerably exceeds that of Mars, but even of several of the small planets, which, indeed, all things considered, afford the most favourable means of determining the distance of the Sun by observation.

Looking through the list of determinations by various methods collected in the *Vade Mecum*, I found that one is attributed to Halley by means of his observation of the transit of Mercury at St. Helena in 1677. This is put down as 25", and is of course understood to be very rough. But it may be worth while to point out that this supposed value is founded on misconception. As the transit in question was only observed at one station, the solar parallax could not have been obtained from it. Halley chiefly used it to show experimentally with what accuracy the observation could be made, and to point out that similar observations of transits of Venus would afford, as he thought, the best means of determining the Sun's parallax and distance. Parenthetically, as it were, he indulges in a few conjectural and rather fanciful remarks about the probable amount of the parallax. Considering that it was not probable the size of Mercury (a primary planet) would exceed that of the Moon (a secondary planet) and that the size of Venus (a planet without satellite) would probably be less than that of the Earth (a planet having a satellite) he thought that the Sun's parallax might be taken to be between 10" and 20". And then, finding from Tycho Brahe's acronycal observations of Mars that its parallax in that position was less than 1', he concluded that the parallax of the Sun must be less than 25". This, then, is the value put down in the *Vade Mecum*; but of course it is in no sense a determination of the parallax, only a deduction that its value does not exceed that amount, whilst it has nothing to do with the transit of Mercury.

Yours faithfully,

W. T. LYNN.

Blackheath, 1898, July 1.

"Sunset" from a Legal Point of View.

GENTLEMEN,—

I think the Altrincham Magistrates were wrong in the decision they gave in the case of the cyclist without lights as cited in the '*Observatory*' for July 1898. By the Act 43 & 44 Vict. c. 9, "The Statutes, Definition of Time, Act, 1880," it is enacted that whenever any expression of time occurs in any Act of Parliament, &c., the time referred to shall (unless it is otherwise specifically stated) be, in the case of Great Britain, Greenwich Mean Time. Hence it follows that if cyclists must carry lights after sunset, the "sunset" in question means sunset at Greenwich,

albeit that, as a local fact, at Altrincham or Carlisle, the Sun has not yet set.

I am, Gentlemen,
Your obedient Servant,
G. F. CHAMBERS.

1 Cloisters, Temple,
1898, July 7.

[With all due respect to the opinion of a legal authority such as our esteemed correspondent, we venture to doubt whether the word "sunset" is an "expression of time." We should rather have thought it a statement of a fact, and that the legal "time of sunset" would be the Greenwich Mean Time when the Sun set at the place in question. We are aware, however, that this is still not a perfectly definite statement, for we believe that a legal answer to the question "What is sunset?" has not yet been determined.—EDS.]

Visibility of Alcor.

GENTLEMEN,—

In a paper by Dr. T. J. J. See in this month's number of 'Popular Astronomy,' on "Jupiter's Satellites visible to the Naked Eye," he speaks of the visibility also of Alcor or γ Ursæ Majoris, and says that he is surprised how it was that the Greeks overlooked it, and also quotes Humboldt's remark on its easy visibility in Cumana and on the cordilleras of South America, though he had seen it less frequently and less distinctly in Europe and in the dry steppes of Northern Asia. Mr. Gore's expression about it is that there is "no difficulty" in seeing it with the naked eye now, though it would seem to have been fainter in ancient times. This is probably the reason why it seems not to have been noticed by the Greeks (the proof of which is, I suppose, that it is not found in Ptolemy), and it is well known that the Arabic designation *Saidak* is taken to be an indication that they looked upon its perception as a test of a keen sight. Of course, the only difficulty (if there be any) lies in separating it from Mizar or ζ Ursæ Majoris; but I well remember its being pointed out to me when a child by a peasant, who said that it was called "Jack on the middle horse." It has often occurred to me since how easy it would be to make a joke on the Bayer letter in connexion with this, and take Jack as being a postillion (the peasant's idea), and saying "gee" to the second horse of the wain, the drawback being that the imaginary horses go backwards instead of forwards, and the cart veritably pulls them—agreeing better with the bear similitude of the constellation, the animal carrying its tail in the normal way behind it.

As the proper motions of Mizar and Alcor are nearly the same, there could have been no more difficulty in separating them in ancient than in modern times, which increases the probability that the latter may have become brighter in recent centuries.

Yours faithfully,
W. T. LYNN.

Blackheath, 1898, July 18.

Astronomy in Parish Registers.

GENTLEMEN,—

Parochial registers are scarcely the documents in which we should expect to find much in the way of astronomical allusions. Still they are not entirely without such reference.

In Hutchins's 'History of Dorset,' ed. 2, vol. ii. p. 309 (Register of Sydling S. Nicholas, Baptisms), there is stated to be the following:—"1602, Oct. 2. Agnes Wytinge. At the same instant there was an eclipse of the Sun." A magnitude of 10 digits would cause sufficient gloom in a clear sky to attract attention. This was total for a few seconds at Naples, where Kepler speaks of "circumcirca rubentem et flammeum splendorem æqualis undique latitudinis." If registers were well searched it is possible that some notes about the 1715 eclipse might be found, which might be even useful in determining the limits of the shadow.

According to Hall's 'History of Nantwich,' the following lines are in the Burial Register of that parish about the principal comet of 1618:—"This yeare last past, 1618, in the month of Novembre many times their appeared eastward a blazing star betokenninge Godd's judgments toward us for sin. The Lord in mercye be merciful unto us" (page 122).

It is also possible that mention of brilliant auroræ that excited much remark, if not alarm, may be found in such registers.

Melplash Vicarage, Bridport.
1898, June 23.

Faithfully yours,
S. J. JOHNSON.

Discovery of Encke's Comet.

GENTLEMEN,—

I have much pleasure in reporting to you my discovery of Encke's Comet on the evening of the 11th ins ant. The discovery was effected by means of the 4½-inch equatorial, with the help of Iwanow's ephemeris in No. 3490 of the 'Astronomische Nachrichten.' The comet presented itself as a small round nebula condensed a little towards the centre, and was just on the confines of the band of bright sky along the western horizon. Five rough pointings with circle-readings were all that could be obtained on this occasion. Last evening, however, I succeeded in obtaining four comparisons with a square bar-micrometer with two stars in the 'Bonn Durchmusterung,' namely B.D. +11°, Nos. 1356 and 1370. The approximate place resulting from the first three comparisons, for the fourth was made just as the comet was on the point of setting, is for 6^h 18^m local mean time. R.A. = 6^h 53^m 29^s; Decl. = 10° 34' North. Clouds along the horizon prevented a repetition of the observations this evening. The comet is not high enough to be observed with the 8-inch telescope but I trust to get a good series of positions with this instrument during the latter part of the present month and during July. I cannot send further information at present, as the European mail

closes this evening at Windsor. The Melbourne Observatory was notified of the discovery on the evening of the 11th, and another telegram was sent this evening to be forwarded to Kiel.

Observatory, Peninsula,
Windsor, N.S.W.
1898, June 13.

I am, Gentlemen,

Yours faithfully,
JOHN TEBBUTT.

OBSERVATORIES.

YALE.—Dr. Elkin's Report on the work done at the observatory under his charge during the past year (the Report is dated 1898 June 18) is brief, but gives promise of interesting results which we shall hope to see in the future. Dr. Chase has continued with the heliometer the series of measurements of stars which have large proper motion, for determination of their parallax, which he has been engaged on for several years, and has now completed the planned series of 12 measures each of 84 stars. In a few months he hopes to bring the total of investigated stars to over 100. The reductions are progressing, and "promise to lead to results of considerable interest and importance." The publication of these results for the first-magnitude stars, the observations of which were finished last year, appears to have been delayed in order to investigate whether there is any possibility of a systematic error, owing to varying refrangibility of the light of stars of different colours, a subject which has lately been discussed in some papers in the 'Monthly Notices.'

It may be remembered that there is in use at Yale an instrument which may be shortly described as consisting of several cameras on one equatorial mounting, used for photographing meteors. The use of this, judging from previous Reports, has not met with marked success, and it is encouraging to see that during the past twelve months ten meteor-trails belonging to various radiants have been secured. In view of the approaching expected Leonid display, the National Academy of Sciences has granted a sum of money to supply another instrument of this kind for use at a second station a few miles distant to determine, if possible, the actual path of the meteors.

TEMPLE OBSERVATORY, RUGBY.—The leaflet issued by Mr. G. M. Seabroke, the Honorary Curator of this modest institution, as Annual Report, is remarkable for its briefness. The Observatory was opened on 69 nights during the year 1897 to members of Rugby School, and 205 names appear on the register. The measurement of double stars has been carried on by the Curator, and by Mr. Highton and Mr. Atkinson. The equatorial is now lighted by electricity, and the buildings and instruments are in good order.

PUBLICATIONS.

HIMMELSKUNDE *. Von J. PLASSMAN.—This work is intended as an introduction to students of the higher astronomy, and also for intelligent readers generally. As a German work written for Germans it would probably take a fair position, but as it is written in German character it scarcely appeals to the majority of English readers. Herr Plassman has endeavoured to combine in one book the elements of physical astronomy and the subject-matter which is embraced by the elastic expression “popular astronomy.” Assuming the reader unacquainted with spherical astronomy, he gives us a little work on formulæ with examples of time of rising and setting of Sun. The usual definitions are dealt with in good style, the calendar receives more than usual attention, and tables are given to facilitate certain time-reductions. Aberration and Parallax are well illustrated and explained, and the chapters on Kepler’s and Newton’s laws are full and good. To the chapter on Precession there is annexed a well-prepared plate of the zodiac of Denderah, which will show the comprehensive character of the book.

The descriptions of the planets introduce the latest observations, but call for no special remark. We note that a full account of Easton’s Theory of the Milky Way is included, as also a theory due to the Author himself.

As might be expected in a book by Herr Plassman, the chapter on variable stars is distinctly good, but to English and American readers the treatment of double-star work, which is barely mentioned, would appear strange.

The later chapters of the book are devoted to astronomical optics and to a history of astronomy, illustrated with portraits of some well-known German astronomers, and though, as we have said, the book is at a disadvantage owing to the language in which it is written, still its illustrations and diagrams may supply a sufficient reason for its finding a place in an English library.

NOTES.

COMET NOTES.—The following elements of Comet *c* 1898 (Perrine) have been deduced by Prof. Berberich from observations on June 14, 20, 23 (Ast. Nach. 3504):—

T	.....	1898 Aug. 16.34 Berlin M.T.
ω	.....	204° 55'
Ω	.....	259 9
i	.....	70 1
log q	.....	9.8030

* ‘Himmelskunde,’ von J. Plassman. B. Herder: Freiburg im Breisgau, 1898. Paper, 13 marks; cloth, 15 marks.

The following ephemeris is for Berlin midnight, the brightnesses at discovery being taken as unity:—

		R. A.			Decl.	Brightness.
		h	m	s		
Aug.	2.....	7	23	51	26° 44' N.	6.3
	6.....	7	40	18	22 5	7.1
	10.....	7	53	36	17 8	7.8
	14.....	8	9	0	11 56 N.	8.4
	30.....	9	17	12	9 14 S.	7.0
Sept.	15.....	10	36	0	24 43	3.7
Oct.	1.....	11	57	12	37 44	1.8
	17.....	13	11	42	43 29 S.	0.9

The brightness thus reaches a maximum about August 18, but at this time the comet will be lost in the sunshine; it will be favourably placed for observers in the southern hemisphere during September, and a long series of observations should therefore be secured.

Dr. Schon has pointed out the resemblance of the orbit to that of the Comet Pons-Brooks, which appeared in 1812 and 1884, and whose elements we give for comparison:—

T	1884 Jan. 25.8.
ω	199° 15'
Ω	254 6
i	74 3
log q	9.8894
Period ..	71.48 years.

The present comet may therefore be a member of the same family of comets as that of Pons-Brooks.

The following ephemeris (for Paris midnight) of Perrine's first comet of this year (*b* 1898) is by S. K. Winther (Ast. Nach. 3504):—

R.A.				N. Dec.	R.A.				N. Dec.
h	m	s	°		h	m	s	°	
Aug. 2....	5	58	10	52 37	Sept. 3....	6	29	35	51 9
10....	6	8	51	52 9	11....	6	32	34	50 59
18....	6	17	40	51 44	19....	6	33	27	50 52
26....	6	24	35	51 25	27....	6	32	3	50 47

Brightness 0.07 on Aug. 2, 0.04 on Sept. 27.

The following ephemeris (for Berlin midnight) of Comet *c* 1898 (Coddington-Pauly) is by Prof. Berberich (Ast. Nach. 3504):—

R.A.				S. Dec.	R.A.				S. Dec.
h m s					h m s				
Aug. 2....	13	55	45	47 53	Sept. 3....	13	34	26	56 3
10....	13	45	48	50 0	11....	13	35	38	59 ,
18....	13	39	14	52 7	19....	13	39	6	61 4'
26....	13	35	34	54 18	27....	13	44	46	64 4'

The brightness is diminishing slowly but steadily, being 0·93 on August 2, and 0·65 on September 11 (that on July 25 is taken as unity).

The following elements of Giacobini's Comet (*g* 1898) are by M. Javelle:—

T	1898 July 24·894	Paris M.T.
ω	21° 55'	
Ω	278 17	
i	166 51	
log q	1·5043	

Ephemeris for Berlin midnight.

	R.A.			S. Dec.		Brightness.
	h	m	s	°	'	
Aug. 2.....	13	58	1	4	35	0·37
6.....	13	52	7	3	58	0·34
10.....	13	47	32	3	29	0·31
14.....	13	44	0	3	5	0·29
18.....	13	41	13	2	46	0·27
22.....	13	39	8	2	31	0·25
26.....	13	37	34	2	19	0·24

The brightness on July 7 is taken as unity.

An ephemeris of Wolf's Comet will be found in the May number. The comet is moving in exact accord with this ephemeris.

It appears that the first to observe Encke's Comet at the present return was Mr. John Grigg, of Thames, New Zealand. He used an ephemeris of his own construction, and with its aid detected the comet on the evening of June 7; it was then in the constellation Gemini, and only 3° above the horizon. It is very satisfactory to find that zealous amateur astronomers are multiplying in the Southern Hemisphere.

A. C. D. C.

OBITUARY.—We have been informed of the death, on July 6th, of Dr. Hermann Romberg, recently of the Pulkova Observatory.

Hermann Romberg began his astronomical career at the Berlin Observatory, where he studied and observed under Encke. In 1862, through the instrumentality of Mr. Hind, he came to England to take charge of Mr. Gurney Barclay's Observatory at Leyton, Essex. During the two years he remained here he contributed various notes to the 'Monthly Notices' on the subjects of cometary orbits, and on observations of small stars near Procyon and γ Andromedæ. The results of his work at Leyton form Vol. I. of the 'Leyton Observations,' which consists of a short catalogue of double stars and planetary and cometary observations. In the spring of 1864 Mr. Romberg was appointed to a position in the Berlin Observatory, the vacancy being caused by the death of Prof. Encke and consequent promotions. He remained at Berlin

until 1873, when he joined the staff of the Poulkova Observatory, where he worked with the meridian-circle, of which he appears to subsequently to have had charge. He published several papers on subjects connected with this instrument, and the standard catalogue of stars for Epoch 1875, issued in his name, forms a volume of the 'Poulkova Observations.' Dr. Romberg was 63 years of age at the time of his death.

WORK AT THE LOWELL OBSERVATORY, ARIZONA.—Sir Robert Ball has kindly lent us Dr. See's letter which he read at the last meeting of the R. A. S. (see p. 257, July) for publication of some extracts which may prove interesting:—

In the course of the sweeps which resulted in the discovery of these stars and the measurement of 500 other objects recognized by previous observers, we examined carefully at least 100,000 stars brighter than magnitude 10. It is needless to say that the execution of so extensive an undertaking has left us little leisure since the beginning of the survey, August 1st, 1896. I need not say to you that by no means all clear weather is suitable for micrometric work on the delicate objects which have come under our examination during the past two years. We find by experience that even in this serene climate the best nights are not over-abundant. Yet on every quiet night we invariably found some difficult object which had escaped all previous observers. On exceptionally fine nights we not infrequently had remarkably good fortune, returning at sunrise with a number of veritable gems of the sky.

I am of opinion that the air here enables us to realize the full theoretical power of the great telescope. The air is found, by the studies which Mr. Douglass and I have made on the atmospheric currents, to be now and then absolutely quiescent, scarcely any trace of motion being visible either about the Observatory or at a great elevation above the Earth.

The lens of the 24-inch telescope is probably the best large objective Clark ever figured, as the maker himself frequently remarked, and hence an exceptional power ought to enable us to detect more difficult things than can be seen even with the largest telescopes, which in every case are located in inferior atmospheres, and can seldom be utilized to their full theoretical effect. The argument, therefore, that a thing which is visible at all must of necessity be visible in the telescope of largest aperture is manifestly false. Mr. Douglass used to say to me, when he was obtaining the first of his beautiful results on Jupiter's satellites, that the markings required such steadiness of image that others who would not be able to see them distinctly would declare that they did not exist. The difficult planetary and satellite markings discovered here by Mr. Lowell and Mr. Douglass and occasionally by me, ought to be visible at rare intervals elsewhere, provided the observers are experienced in such work and utilize the whole of their opportunities. We have no hope they will be seen in any other way.

THE FIRST SATELLITE OF JUPITER.—In the foregoing note we have Dr. See's testimony to the excellent conditions for observing at the Lowell Observatory, Arizona. Here we have to note some results doubtless due to this good seeing.

Mr. Douglass made observations in Mexico and in Arizona, between 1897 February and June, of the markings on the first satellite of Jupiter. The earlier observations, although they showed evidence of a rotation, were not sufficiently continuous to give of themselves an accurate value of the period, so that Mr. Douglass had to have recourse to the method of discussing the changes in

the apparent elliptical shape of the satellite, which had previously been used by Prof. W. H. Pickering in his similar research when he deduced a retrograde rotation of the satellite. By discussion of the changes of ellipticity and also of the markings, a rotation of the satellite in the *direct* sense was deduced, the period being $12^h 25^m.8$. Combining the period with the observed markings, Mr. Douglass finds it possible to draw a map of the satellite. Micrometer measurements show that the satellite has a very elliptical form. The angular value of the polar diameter is given as $0''.84$ and the equatorial $1''.07$, one second of arc being equivalent to 1990 miles, and the directions being respectively perpendicular and parallel to the belts of Jupiter.

THE CONSTANT OF ABERRATION.—In a very brief note in *Ast. Nach.* 3504 Dr. Doberck states the result of an investigation of the value of the aberration-constant made by Talcott's method.

The complete value found from all his observations is $20''.477$.

The value found from stars of average magnitude 4.4 is $20''.639$.

"	"	"	5.4 is $20''.430$.
"	"	"	6.4 is $20''.385$.

The fact of the variation of the value of the constant with the magnitude of the stars from which it is determined, if well established, is a point of considerable interest. We look forward to seeing details of Dr. Doberck's investigation.

THE BEN NEVIS OBSERVATORIES.—With great regret the Directors have announced that the High- and the Low-level Observatories at Ben Nevis will cease to exist in October of this year owing to want of funds. There is no way, so far as the Directors can see, by which these great first-class meteorological observatories can be continued, except by further aid from the State. By the establishment of these observatories and the unique observations made at them a great experiment has been carried out with signal success, but the experiment has been, as anticipated, a costly one. A sum of no less than £18,150 has been expended on the inquiry, and the sum has been obtained by contributions partly from scientific bodies, but mainly from the public. With much pleasure, the Directors are able to report that in a large sense the objects aimed at have been attained. A long series of hourly observations has been obtained by night and by day without a break over a period of fifteen years, though these included eye or other observations outside in the severe climate of the top of Ben Nevis, forming a set of observations quite unique, nothing similar having as yet been done at any other high-level observatory in the world.

From the answer to a question asked in the House of Commons on July 26, it appears that a sum of £15,300 is placed annually at the disposal of the Meteorological Council for distribution as they think best in the interest of meteorological research. Of this sum £350 has been granted to the Ben Nevis Observatories.

The Chancellor of the Exchequer is not prepared to make a special subsidy to the Observatories, but suggests that the matter rests with the Meteorological Council, who have ample funds to maintain these institutions if they think fit.

THE SOLAR PHYSICS COMMITTEE.—The following paragraph appeared in 'Truth' for 1898 June 29 :—

"Our Governments, as a rule, are not prone to the endowment of scientific research. Peculiar interest, therefore, attaches to the additional grant of £5000 contributed by the Treasury this year to the Solar Physics Committee. The Solar Physicists, I understand, are mainly occupied in investigating sun-spots, and other eccentricities in the orb of day, under the direction of Sir Norman Lockyer, K.C.B. According to Sir Norman, who is responsible for a number of other astronomical theories, the work may in the future throw considerable light upon the vagaries of the weather. I know a man who thinks it may enable us to foretell the course of the Stock Markets during the next autumn, and the winner of the next year's Derby. We shall see. In the meanwhile, the increased endowment of the Solar Physical Research has enabled Dr. W. S. Lockyer, a son of Sir Norman, to be appointed to the staff of researchers, and a bird in the hand is worth two in the bush."

A VERY LARGE FIREBALL.—A correspondent sends us an account of an enormous fireball observed by him on July 14 when off Beachy Head in the steamship 'Brighton Queen.' He states that the apparent size of the object was equal to the full Moon, that it travelled from south to almost due north. The exact point of the heavens where it appeared was not noted, but it disappeared at a low altitude. It left a fiery train many degrees long, which endured for fully fifteen seconds.

FROM accounts in the daily papers we gather that the Rev. J. M. Bacon has made the balloon ascent for scientific purposes that he spoke of at the June Meeting of the Astronomical Society.

THE University of California has conferred the honour of LL.D. on Prof. J. M. Schaeberle.

FROM AN OXFORD NOTE-BOOK.

SOME few years ago Mr. Chandler declared himself so well satisfied with the definitive results he had obtained for the motion of the Earth's axis, that he was ready to prepare ephemerides for the position of the pole at any epoch; and these ephemerides have since been regularly given in the 'Astronomical Journal.' Herr Albrecht, on the other hand, recently published in the *Ast. Nachr.* a discussion of observations for latitude, and the resulting observed motion of the pole. He did not compare his results with Mr. Chandler's ephemeris, but the comparison is readily made, and shows at once that while certain main features of the actual motion (as determined by Albrecht) are well represented by the ephemeris, there are also sensible discrepancies. It would seem, for instance,

as though the ephemeris, while giving approximately the same path for the polar motion, was about a month behind the actual motion at the present time. I have been hoping to see some discussion of this most important matter, but, as yet, have seen none. Possibly I have overlooked it, especially if it be not in one of the two journals mentioned. In spite of the discrepancies, however, the observations confirm prediction so remarkably as to cut the ground from under the feet of those who wish to put aside the Variation of Latitude as "empirical" or not proven in (for instance) discussing the constant of aberration. The evidence for its existence, and for the general truth of the law formulated by Mr. Chandler, is already overwhelming, and new observations only add to it.

DURING the last month I have been officially visiting some of the landed property of New College, of which my University office makes me a Fellow. A great part of this property has been in possession of the College since its foundation 500 years ago, having been presented by the founder, William of Wykeham, as the original endowment; the remainder has been presented by other benefactors. Most of it was, until recently, let on copyhold tenure, and the Warden and Fellows of the College made an annual round, called a "Progress," to collect the "fines" and tithes, which made up their income. The Warden drove in a carriage, in state, and the Fellows rode on horseback, one of them acting especially as "outrider," and going on ahead to secure a proper reception and lodging for the "Progress." With the gradual elimination of copyholds in favour of the modern system of rack-rents, the "Progress" has lost its chief importance; but it is retained as an annual ceremony, the Warden and his "outrider," with the Steward of the estates, paying a series of visits to the tenants each summer. The office of outrider, filled by each Fellow of the College in turn, this year fell to me. It is nearly a century since the "outrider" rode on horseback—he long ago accepted a seat in the Warden's carriage—and so my equestrian performance was not tested. I did, indeed, offer to accompany the expedition on a bicycle, but the Warden decided that this innovation should be reserved for the occasion when he exchanged his carriage for a motor-car.

THE experience was wholly delightful. The weather was perfect; we were warmly greeted and hospitably entertained, and we saw beautiful places and curious things. Among the latter was a brass inscribed with the date of the *thirtieth* of February, 1508. There is no doubt at all about the figures, which are three clear and exactly similar X's, and the whole inscription, which is quite clear and legible, reads as follows:—

Here lyeth Jane Smyth sumtyme the wyf of George Smyth of Adderbury the whiche dyed the XXX day of February in the yere of our Lord M V^o VIII on whose soule thū have mercy amē.

Is there any plausible explanation of this odd mistake? for I suppose it to be a mere slip. The curious can see the inscription in Adderbury Church, which is, moreover, a beautiful building quite worth a visit on its own account.

In some of the outlying districts the time shown by the church clocks was not very Greenwich. One vicar, whose clock was nearly ten minutes fast, gave as a reason for not altering it that he had read a book called (I think) the 'Curate of Cumberbatch,' wherein it is related how the hero set himself to keep the church clock sympathetic with his own watch, which had never deceived him up to that moment, but which went traitorously a full half-hour wrong the first time it was used to regulate the church clock; so that the village of Cumberbatch was thirty minutes late for its engagements with neighbouring villages. This terrible warning had been too much for the vicar, and he had determined to let the church clock alone, or at least not to have the sin of setting it wrong on his conscience.

This vicar was not so enterprising as a bishop I heard of the other day from a most trustworthy source. I "had it from one who had it from one who had it from the bishop himself" that he (the bishop) used to keep his kitchen clock right within a second or two by observations with a sextant, and, circumstantially, that his artificial horizon was made of treacle with a modicum of rum added. Further, that the chief trouble of this right reverend astronomer was the rapid evaporation of the said artificial horizon, which was kept between times in a drawer (unlocked) in the kitchen, and was yet found, even in this unexposed position, to lose half its bulk in a marvellously short time. Finally, that the addition of a little laudanum (I think it was) to the mixture quite cured this tendency to "evaporation," so that the only matter still to be determined is whether this odd fact is of interest to chemists or more nearly concerns dentists as proving that there was a "sweet tooth" somewhere in the kitchen. Anyway the bishop kept his clock right without help from the post-office; and some of our country clergy who have been high wranglers in their time might find it a healthy amusement to do the same.

It may well be, however, that the cautious vicar is on the right side. A good theoretical knowledge, not supplemented by a practical training, may lead a good man astray. They used to tell a story at Cambridge (probably they tell it still) of a Senior Wrangler who set himself to find the time of sunrise on a given day at a given place, and was much distressed when the answer came out in *thousands of miles*. For such it is better to leave the church clock alone, at any rate just at first. By the way, have I told before (if not it is worth the telling, perhaps) the more recent story of a candidate who was asked how to determine the time at sea, and who began his reply with "First set the transit-instrument up on deck —!"

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

SEPTEMBER, 1898.

No. 270.

The Problem of Coronium.

PROFESSOR NASINI's recent announcement that he is on the track of a volcanic gas probably identical with the solar coronium, raises the hope of its actual capture, and directs attention to its possible qualities. These have as yet been studied only in the Sun, where it exists in prodigious volumes, doubtless of relatively small mass. It is the leading coronal ingredient—the one gaseous substance clearly recognized as pervading the coronal structure. Others may indeed be associated with it, but none that can as yet be specifically distinguished; while the upshot of the latest eclipse-work has been to relegate to lower solar levels all *known* forms of matter—notably hydrogen, helium, and calcium,—and to draw a sharp dividing-line between coronal and chromospheric chemistry.

The true coronal spectrum appears to be represented by the 'rings' photographed with the prismatic camera during totalities; and Sir Norman Lockyer has determined the approximate wave-lengths of eight such images from the African negatives of April 16, 1893. That formed by the green ray "1474 K" (equivalent to λ 5317) is by far the strongest of the collection; but it remains to be seen whether it is *molecularly* independent of them. The question, in other words, arises: Are any of the coronal rays, besides its familiar spectroscopic badge, claimed by coronium? Imprisoned in a vacuum-tube, and submitted to the *examen rigorosum* of laboratory methods, it may before long give a direct and satisfactory reply; but indirect forms of interrogatory should not meanwhile be wholly neglected.

Several are available. The most immediate, if the most abstract, consists in the search for numerical relations among the measured lines of the coronal spectrum. Any that range themselves with "1474 K" in a series of the Balmer type would thereby establish an indefeasible right to a common origin. Those most likely to do so, judging from their brightness, have the wave-lengths λ 4233 and λ 3968. Some fruitless experiments have, we believe, been already

made in this direction by Professor Campbell; but they might well be renewed. They may, indeed, prove finally abortive. The spectrum of coronium, like that of calcium in prominences, is perhaps by the tenuity of the radiating substance, reduced to an elementary stage of simplicity; in which case, the prismatic rings of the solar aureola indicate its composition out of a whole group of strange gases.

This involves no glaring improbability; but is it the fact? A definite reply may be obtained, should refined calculations come to naught, by means of direct spectroscopic observation.

The behaviour of coronium in the Sun is highly anomalous. It shows no sign of being subject to gravitational pressure, or of participating in solar atmospheric motion. The ray emitted by it remains everywhere straight and fine. It does not belong to the chromospheric spectrum as such, although inevitably seen projected upon it. The photographed "flash" includes no "long arc" at $\lambda 5317$; nor was any light of this particular quality derived from the prominences visible during the eclipses of 1893 and 1896*. On occasions, nevertheless, of unusual solar excitement, eruptive prominences appear clothed with this enigmatical vesture. They are, however, invariably small objects (in a relative sense), the recorded height of a coronium-outburst, so far, being 33". This lightest of gases—as it is assumed to be—comports itself in the chromosphere precisely after the manner of a metallic vapour. This is a most remarkable circumstance; but what we are just now concerned with is the simple enquiry whether prominences formed on the green coronal ray shine simultaneously with other coronal colours. A cursory inspection might suffice to decide; and an affirmative result, by providing associates for the still solitary "1474 K" line, should lead to an incalculable extension of knowledge as regards the distribution of coronium throughout the universe.

Information on the subject is at present very defective. Outside of the Sun, coronium has not been convincingly identified. Indications of its presence in various heavenly bodies have indeed been gathered, but they need to be multiplied and fortified. Thus, Professor Campbell observed in 1893 a faint ray about $\lambda 5322$, "possibly the coronal line at $\lambda 5317$ "†, in the spectra of the nebulae—namely, the Andromeda planetary N.G.C. 7662 (= G.C. 4964), and Webb's bi-nuclear object in Cygnus (N.G.C. 7027), in both of which the Wolf-Rayet "blue band" glows with unusual common intensity. A photographic search for additional coronal lines, notably those at $\lambda 4223$ and at $\lambda 3987$, would be desirable. Its success would provide a firm basis for further investigations.

Coronium-absorption is suggested by a dark line at $\lambda 5316$ recorded in the spectrum of Rigel by Professor Keeler‡; and coronium-emission probably contributes its quota to the blaze of

* Shackleton, 'Knowledge,' Jan. 1898.

† Astronomy and Astro-Physics, vol. xiii. p. 501.

‡ Ibid. p. 489.

Sept. 1898.]

Almanacs.

"new stars." In Nova Cygni and Nova Aurigæ, at any its presence was scarcely doubtful; and Professor Campbell spectrographic studies of the latter in February 1892 somewhat forcibly that the *blue* coronal line at $\lambda 4223$ brightened and broadened no less than the fundamental *green*. Their apparent association gives a hint that should not be sight of. Even in laboratory experiments it may prove of Professor Nasini evidently obtained no photographs of the *fatara* spectrum: yet they would be well worth having: for might possibly bring into view a double coincidence affirming indisputably the existence and detection of terrestrial coronium.

AGNES M. CLER.

Almanacs.

[Continued from p. 305.]

WE have now come to the period of the classic fight between Swift and Partridge.

Partridge was born in 1644, and followed the trade of making at Covent Garden; but having acquired some knowledge of Latin, Astronomy, and Astrology he considered himself equal to the task of foretelling such paltry affairs as the dealings and the fall of States, to say nothing of weather prognostications. Accordingly he issued an almanac which differed little from others of the period, except in its important unforeseen result. It called forth the humorous powers of Swift and supplied an inexhaustible store of amusement for other of the time.

Swift began his satire by issuing '*Predictions for the year wherein the Month and day of the Month are set down, the Pe named and the Great Actions and Events of Next Year particularly related as they will come to pass. Written to prevent the People England from being further imposed upon by the Vulgar Alman Makers.*'

Herein he discusses the art of Almanac-making, and proceeds to his predictions. He states "My first prediction but a trifle, yet I will mention it to show how ignorant and sottish pretenders to astronomy are in their own concerns. relates to Partridge the almanac-maker. I have consulted star of his nativity by my own rules, and find he will infallibly die on the 29th March next, about eleven at night, of a fever; therefore I advise him to consider of it and settle his affairs in time."

Partridge, after the 29th March, publicly denied that he died, which, as may be supposed, increased the fun, and the was kept up in the '*Tatler*.' Swift, not content with mere kill

wrote "An Elegy on the supposed Death of Partridge, the Almanac-maker," and furnished the following epitaph:—

Here, five foot deep, lies on his back
A cobbler, starmonger, and quack,
Who to the stars, in pure good-will,
Does to his best look upward still.
Weep, all ye customers, that use
His pills, his almanacs, or shoes;
And you that did your fortunes seek,
Step to his grave but once a week.
This earth which bears his body's print,
You'll find has so much virtue in't,
That I durst pawn my ears 'twill tell
Whar'er concerns you full as well
In phisic, stolen goods, or love,
As he himself could when above.

Swift's writings amused the public, and had the effect of severing the connection between Partridge and the Corporation, under whose direction the almanac was published. Of course the Company found another prophet.

Tanner's almanac appeared in 1656, but enjoyed little fame; yet in 1698 the '*Vox Stellarum*' of Francis Moore, a mere copy of Tanner's *, was published, and, strangely enough, rapidly gained in popularity. Perhaps the best estimate of the position of Moore's Almanac is given by Drummond in 1820. Drummond was a great believer in the ancients, *i. e.* he considered, and indeed ably argued, that their knowledge was not mere guess-work, but deductions from observation and a high state of culture. In his memoir on 'The Antiquity of the Zodiacs of Esneh and Dendera,' after complaining of Delambre's method of treating the subject of ancient knowledge, he has the following passage:—

"If two Asiatic astrologers were now to visit England, and to learn a little of our language, it is probable that they might carry home with them more of Moore's Almanac in their heads than of Newton's Principia. Let us imagine that one of them mixed something of both in his mind, and told his countrymen of some of the splendid discoveries in science made by the English; while his companion recited verses from the wizard Moore, and assured his hearers that we were all believers in the astral influences. Then, if in the revolution of ages the descendants of these Asiatics became skilful astronomers, while England had fallen from her high estate, had fallen even as Babylon *has* fallen, they would believe, on the principles of M. Delambre, that the English were astrologers but not astronomers; that Moore was our great philosopher, and that Newton guessed at the doctrine of gravitation, as Herschel has since guessed at the existence of the planet Uranus."

We shall have occasion to again refer to 'Old Moore,' but in

* The Rev. S. J. Johnson thinks Partridge's Almanac was the continuation of Tanner's.

the meantime it is worth keeping on record that the successor to Moore* as compiler of the almanac was Mr. Henry Andrews, a computer of the 'Nautical Almanac.' His son, in a letter to Mr. Robert Cole, says:—"My father's calculations, &c., for Moore's Almanac continued during a period of 43 years, and although he increased the sale of the work from 100,000 to 500,000, yet, strange to say, all he received for his services was £25 per annum."

Let us now turn to something more respectable. The 'Ladies' Diary' was started in 1704 by John Tipper, a schoolmaster at Coventry. Disclaiming astrology, prognostications, and quackery, he endeavoured to induce the fair sex to take up the study of mathematics as a source of entertainment as well as instruction. Such a venture seemed doomed to failure; but by presenting questions in versified enigmas, and judiciously inserting cooking receipts, biographies of celebrated women, and other matters peculiarly interesting to the sex, it gradually gained ground, and to the credit of the ladies it is gratifying to note that it was so far successful as to raise up, in 1741, a rival denominated the 'Gentlemen's Diary.' The two continued to run independently to so recent a date as 1841, when they were amalgamated. In 1733 Benjamin Franklin published at Philadelphia 'Poor Richard's Almanac.' It contained the usual astronomical information, besides many pleasant and witty verses, jests, and sayings. The little spaces between the remarkable days of the Calendar he filled with proverbial sentences inculcating industry and frugality. These were afterwards collected and published in a small tract under the title of 'The Way to Wealth,' and enjoyed an immense sale in America and England. This almanac bears a family likeness to that of 'Poor Robin.' It is easily conceivable that the circulation of such almanacs as 'Poor Richard,' 'Poor Robin,' the 'Ladies' Diary,' and the 'Gentlemen's Diary' must have, in the course of time, considerably weakened the astrological almanacs, which had not completely recovered from Swift's onslaught. Our true emancipation really dates from the year 1775, when Thomas Carnan, a bookseller, had the temerity to issue an almanac without the authority of the Stationers' Company. Of course Thomas was swooped down upon and haled before the Court of Common Pleas, where, to the astonishment of the Company, and doubtless also to the astonishment and glee of the said Thomas, his action was upheld, and overboard went the legal monopoly. Lord North, four years later, introduced a bill to again legalize the monopoly, but through the energy of Erskine it was rejected by a majority of 45. The Company, however, still kept possession of the trade by their influence over the book market, in which they were helped by the stamp duties†. Each almanac had to pay a stamp

* Moore was born in 1744, died 1820.

† Selling almanacs unstamped rendered the offender liable to a term of imprisonment not exceeding three months, and the person apprehending the offender received 20 shillings reward.—Geo. II. c. 19, § 26.

duty of 15*d.* per copy. This duty was repealed in 1834, and almanacs henceforth improved and waxed strong and plentiful.

A few years before this, however, 'The British Almanac,' of the Society for the Diffusion of Useful Knowledge, was published. The Companion to this contains standard information on a great variety of subjects. Probably the best known almanac at the present time is 'Whittaker,' although, no doubt, 'Old Moore' still has a large circulation, in the sixpenny and penny form.

But for the fear of being unfair to astrology, these remarks might here have ended. This science spreads itself over at least 90 per cent. of the almanacs herein mentioned, so that, relatively speaking, it has been kept in these notes unduly in the background. Worse still, the patent medicine has been entirely eliminated. This must be remedied.

Mr. Sharon Turner, in his 'History of the Anglo-Saxons,' says :— "Their prognostics from the sun, moon, thunder, and dreams, were so numerous as to display and perpetuate a most lamentable debility of mind. Every day of every month was catalogued as propitious or unpropitious for certain transactions. We have Anglo-Saxon treatises which contain rules for discovering the future fortune and disposition of a child from the day of its nativity. One day was useful for all things, another, though good to tame animals, was baneful to sow seeds. One day was favourable to the commencement of business ; another to let blood ; and others wore a forbidding aspect to these and to other things. On this day they were to buy, on a second to sell, on a third to hunt, on a fourth to do nothing. If a child was born on such a day, it would live ; if on another, it would be sickly ; if on another, it would perish early. In a word the most alarming fears, and the most extravagant hopes, were perpetually raised by these foolish superstitions."

No doubt this credulity was transmitted from generation to generation, and the sole aim in life of the great majority of almanac-makers was to foster it. And they met with success, for notwithstanding the general spread of education the craving for such publications in no way abated, as we have already seen. Let us glance at a few epochs.

A.D. 700.—The venerable Bede, probably the most learned man of his time in England, affirmed that "comets portend change of kingdoms, or pestilence, or wars, or tempests, or drought"—a goodly choice.

A.D. 1000.—From a manuscript* work on astronomy attributed to Ælfric, we learn that the general notions were much the same as in Bede's time, even to the inclusion of the cometary portents.

A.D. 1150.—The feebleness and imbecility of mind spoken of by Sharon Turner was in no way lessened amongst the people †, and

* MS. Cotton. Tiberius, B. v.

† Baron Zach describes an almanac of 1149, in which the propitious and unpropitious days are marked.

even with the learned it appears to have taken up its abode, not in England alone, but throughout Europe. One instance will suffice. To the shame of astronomers* of the time, Christians, Jews, Arabs, and Moors were unanimous in announcing in 1179, that in 1186 a conjunction of all the planets would take place, and it would be accompanied by such terrible ravages that a universal upheaval might be expected, or even the end of the world.

A.D. 1300.—Chaucer's 'Canterbury Tales' teem with such superstition:

The Knight's Tale.

"Some wick aspect or disposition
Of Saturn, by some constellation
Hath given us this."

The Miller's Tale.

"Now John," quoth Nicholas, "I will not lie";
I have y-found in my astrology,
As I have looked in the Moon's bright,
That now on Monday next at quarter night,
Shall fall a rain, and that so wild and wood
That never half so great was Noë's flood.

A.D. 1386.—Stower's MS. Almanac recognizes *u Leonis* as one of Daniel's lions and therefore, "Whoso es born in yat syne he shal be hardy and ietherus."

A.D. 1542.—Dr. Arcandum says: "A man born in Sagittarius is to be thrice wedded, to be very fond of vegetables, to become a matchless tailor, and to have three severe illnesses." As the last attack was to be when he was eighty years old, it probably would not trouble the tailor much.

A.D. 1650.—We have already seen something of the superstition of this period, but one cannot refrain quoting Lilly, who was so great an authority on comets. "The spirits well knowing what accidents shall come to pass, do form a star or comet and give it what figure or shape they please, and cause its motion through the air." Accordingly if it appear in Taurus, "it portends mortality to the great sort of cattle, as horses, oxen, and cows." He further informs us that comets portend "very hard and nipping weather, frosty, dark, cloudy, much snow and wind, strange or unusual hail and tempests."

A.D. 1821.—Moore speaking of eclipses says:—"Some people believe and teach that invisible eclipses do not concern us in their effects and operations. I am not of their judgement, nor is any profound astrologer whose works I have read, from Ptolemy down to Kepler and Tycho Brahe, from them down to the noted Gadbury and Lilly. There is no necessity that the celestial agents, like

* The astronomers of this period included: Abraham Ben Chaija (Spain, 1115), who predicted the coming of Christ in 1358; Solomon Jarchus (French Jew, 1150); Almansor (Moorish Arab, 1150); Robert Grosseteste (Archdeacon of Leicester, 1175-1253).

te restial archers, should see the butt at which they aim. No, no, be assured that as visible eclipses betoken great and public actions, so invisible ones predicate private designs."

A.D. 1808.—The almanacs by Moore and Zadkiel still have large circulations, and are consulted in all faith*. Zadkiel informs us of the following:—

When the Sun is in ben'fic aspect with the Moon it is a good day for asking favours, seeking employment, and travelling for health. Mercury in ben'fic aspect with the Moon is favourable for writing letters; seeking literary employment; dealing with printers publishers, editors, and lawyers; for sending children to school, and binding apprentices. Venus, for courting, engaging maid servants. Mars, for consulting surgeons; Jupiter, for opening shops; Saturn, for dealing with farmers and miners.

Thus we see that this particular imbecility of the human mind is incorrigible: the learning of centuries has been unable to dissipate it.

The Zodiac has been frequently mentioned in this article, and deserves some notice, as it leads to the connection between the almanac and patent medicine. Claudius Ptolemy says:—"Pierce not with iron that part of the body which may be governed by the sign actually held by the Moon." A warning this to surgeons never to operate on the neck or throat when the Moon is passing through Taurus.

But let us have the whole "Anatomy," as the almanacs delight to call it, *i. e.*, "The Dominion of the Moon in Man's Body, passing under the Twelve Zodiacal Constellations," as given in Moore's Almanac for 1821:—

The Head and Face the Ram doth always rule.
The Neck and Throat are governed by the Bull.
O'er the Arms and Shoulders still the Twins preside:
Breast, Stomach, Ribs, the crooked Crab doth guide.
The noble Lion rules the Back and Heart:
The bashful Virgin claims the Belly Part.
The Reins and Loins the equal Balance weigh:
The Scorpion o'er the Secret Parts doth sway.
The Curious Archer doth the Thighs affect:
So doth the Goat our bended Knees protect.
The Legs unto Aquarius' Lot do fall:
The Fish our active Feet their Portion call.

By the way, there is no occult reason for preferring this year to any other. The variations from year to year consist merely in ringing the changes on the adjectives; thus, one-hundred years previously, *i. e.* in 1721, we have "the modest Maid," "the Head-strong Goat," and "the Princely Ram." The capitals we have ever with us.

This is all very well, but it gave a certain amount of trouble looking up these particulars, so some almanacs devoted a column in the calendar to this particular branch of science; thus, for June 1821 the calendar appears as follows:—

* Besides, the e almanacs contain a wonderful quantity of information on many subjects, and are in a cheap form.

Month Day.	Week Day.	Fasts and Festivals.	☉ II.	☿'s signs.	Mutual Aspect and Weather.
1	F	Nicomeda.	11	should.	♂ ♀ ☿.
2	S	[div. m.	12	breast.	Fair and warm,
3	G	S. af. As. Cam. T.	13	stom.	perhaps hot
4	M	Easter Term ends.	13	heart.	now
5	Tu	D. of Ou.	14	back.	about.

This is exceedingly thoughtful of Old Moore. How often do we hear "I feel out of sorts this morning; cannot make out what is wrong with me." Now, anyone having this sort of feeling on 3rd June, 1821, need not have remained long in ignorance; by merely turning up his Moore, he would know exactly. Well, to digress somewhat, it is in this same month Moore predicts "the affairs of Spain wear a serious aspect." So they did in the June of this year of writing, for that matter; but, of course, that is easily accounted for astrologically. 1821 was 77 years ago, and we all know the dreadful and wonderful things attributed to the numeral 7, two of them ought to be able to manage anything.

It may be seen, then, that 'Old Moore' knows more than is thought, and it behoves readers of the 'Observatory' to give heed. Why, in 1898 November, *i. e.* this very year of grace, there is to be "an astronomical discovery which may possibly open up a means of communication between us and Mars." That the discovery will be of immense importance 'Old Moore' unhesitatingly affirms. Is it premature to congratulate Mr. Percival Lowell?

But we are wandering away from our "Anatomy," which is frequently represented pictorially. In general appearance we may liken it to an impression of a medal. Thus, occupying a circular disc is the nude figure of a man, so contorted that his various parts may abut on an annular rim at that part containing the sign of the zodiac and the name of the particular portion of the body.

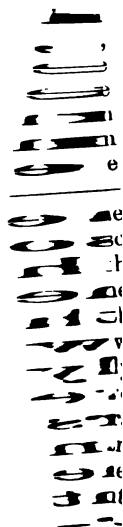
This varied from time to time; for instance, in 'Great Britain's Diary' for 1721 the central space is devoted to a nude woman perched airily on a globe. The legend accompanying this shows "The Anatomy" to have been no mean feature of the almanac:—

Should I omit to place this figure here
My book would scarcely sell another year.
Whit (quoth my Country Friend), *Dye think I'll buy*
An Almanack without the Anatomy?
As for its use, nor he nor I can tell.

If we are to believe Drummond, the Zodiac was portioned out before the Deluge, and the tenants were practically the same as

now. Zadkiel, in his almanac for 1895, says, "Astrology claims the distinction of being the oldest of all sciences; it was kith and kin with all the science and skill of the brightest ages of the world, from the building of the Tower of Babel to the laying of the foundation-stone* of the Royal Observatory, Greenwich." He does not state its position after this. However, by his modesty in not claiming the period before the Flood, we are enabled to fasten the advertisement of patent medicines on the right offenders. The Antediluvians are clearly responsible. It works out in this way:—They invented the Zodiac, and no doubt Noah transmitted it to the Postdiluvians. Now the Chaldeans were great in astrology, so were the Egyptians, and between them they peopled the sky with heroes and others, naturally paying particular attention to the Zodiac. In the course of time each constellation was credited with peculiar powers, and finally the "Anatomy" was developed. Now it is easily conceivable that believers in astrology, more particularly in the "Anatomy," should repair to the fountain-head to have their troubles set right. Indeed we know our own early astrologers either were or called themselves doctors. What more natural than to point out certain remedies (sold only by themselves) for the various complaints. Finally, the general advertising of patent medicines—the biscuits, baking-powders, cocoa, &c. being after-growths.

T. LEWIS.



On the Apparent Increase in Size of the Solar and Lunar Discs when near the Horizon†.

SINCE early times many theories have been put forward to account for the apparent increase in size of the discs of the Sun and Moon when seen near the horizon. We have collected here the principal of these hypotheses for comparison with a series of observations that we have made on this subject.

According to Descartes an error of judgment is responsible for this appearance. The stars seem to be farther away from us when they are near the horizon than when they are in the zenith, owing to the interposition of terrestrial objects. Another explanation of this kind is that one compares the size of the celestial object with that of objects on the Earth. These hypotheses are overthrown by the following observations:—

1. When the Sun or the Moon is observed as it rises above the sea-horizon it appears to us to be twice as large as it seems to be when on the meridian. But this exaggerated size does not continue to exist for long. Very shortly after rising the apparent size of the disc rapidly diminishes; at a small altitude

* Flamsteed did cast the horoscope of the Observatory.

† Translation of a note by M. D. Éginitis in 'Comptes Rendus de l'Académie des Sciences' for 1898, May 9.

The apparent size of the disc is sensibly greater than at the zenith, but it differs much from that at the moment of rising. But the influence of the interposition of terrestrial objects has not sensibly changed, whilst the apparent size of the object diminishes constantly and rapidly. Similar reasons show that comparison with terrestrial objects cannot be the cause.

2. When these bodies rise behind a mountain not far away, and consequently at some altitude, the apparent enlargement is the same as when they are at the same altitude, but with an open horizon such as that of the sea. The size that these objects then seem to have is much less than when at zenith-distance 90° , although terrestrial objects interpose and exert the same influence, if any, upon the apparent distance. So that, in spite of the interposition of terrestrial objects, the apparent diameter does not differ from that which the object has when at the same altitude with an open horizon.

3. The augmentation of the discs keeps on diminishing gradually. If, then, the interposition of terrestrial objects was the cause of the phenomenon in question, this gradual decrease up to the zenith would not happen, for after a certain altitude the interposition of terrestrial objects does not exist.

4. The discs of the bodies at the horizon appear greater as the altitude of the station from which one observes is greater. This is another reason to show that the phenomenon is not caused by the interposition of terrestrial objects, because this does not vary with the position of the observer, and does not exist at all with a sea-horizon.

5. If the discs be observed near a horizon from behind an obstacle which masks the intermediate objects, they appear as large as if the terrestrial objects were not masked.

6. In observing the Sun near the horizon at different altitudes, with the naked eye and then through coloured glasses, no sensible difference was noticed in the size, although some of the glasses were thick enough not to allow either the horizon or the surrounding objects to be seen.

7. In observing the Sun setting from different places, from which the distance of the horizon for several local reasons appeared to us to vary considerably, no sensible differences in the size of this object was remarked.

Alhazen attributed the augmentation of objects near the horizon to the elliptic form of the celestial vault. The first of the observations above opposes this explanation: the distance of the celestial vault, on which the body appears projected, up to a certain altitude appears sensibly the same whatever may be the ellipticity: nevertheless the size diminishes very rapidly as the altitude of the object increases; it becomes only about one-half at an altitude of some degrees, although the radius of the celestial vault has not changed sensibly. The second observation also is not in accord with the hypothesis. In effect, when the Sun sets behind a neighbouring mountain, and consequently at a considerable altitude, the sky is there scarcely elliptical at all; but, nevertheless, the disc of the object appears as great as when one observes it at the same height from a position with an open horizon, where the sky does appear elliptical.

8. In observing the Sun setting, first with a sky very elliptical, and then with a sky nearly spherical, one does not notice any sensible difference in the size of his disc. The fourth observation also does not support this explanation, for the ellipticity of the sky does not change considerably with the altitude: it is true that the higher one goes on a mountain the greater is the distance of the horizon to which one refers the augmented discs; but this increase would not at all account for the augmentation of apparent size that one notices as the zenith-distance increases. On the other hand, if the change of size depended on the

increase of the distance with which one compares the objects, when a body is observed just before setting behind a mountain very far away it ought to appear much greater than when rising at the sea-horizon. But this does not happen—the size of the disc is the same.

9. In observing the Moon when in her first quarter during the night near the horizon, at a time when distant objects are invisible and the celestial vault does not appear elliptical, she generally appears much larger than when in the zenith.

Alhazen also suggests another explanation, according to which the apparent increase of these objects near the horizon happens because they appear less bright than when in the zenith; in consequence of this feebleness of light one thinks them *farther away* when on the horizon than when in the zenith, and consequently *larger*. The following observations contradict this theory:—

10. Having observed the Sun through coloured glasses of different thicknesses and with the naked eye, and consequently with very different brightnesses, we have not found any sensible difference of size at similar altitudes.

11. When the objects are partially masked by clouds near the zenith, and appear even less luminous than at the horizon, their size is not affected.

12. With the same atmospheric conditions one sometimes sees from day to day, and even from moment to moment, the Sun having an apparently different size.

All these last observations are equally opposed to the theory of Gassendi, who attributed the phenomenon to a cause arising from dilatation of the pupil, when the light of the celestial object is enfeebled near the horizon. But besides the Sun and Moon, the constellations also, as is well known, appear larger on the horizon than in the zenith; the phenomenon appears at first sight to be due, at least in a great part, to the ellipticity of the sky. But we have noticed several times that even when the sky appears spherical the constellations seem much larger on the horizon than in the zenith: another phenomenon of the same nature, which may possibly arise from a similar cause, is described by saying that when one sees a man standing upright on the top of a small hill a mile or so away, his figure, projected on an open horizon behind, appears colossal; but when one looks more attentively the magnification disappears, and he is seen quite small.

What is, then, the cause of these phenomena? Notwithstanding the observations that I have made I am unable to adduce any satisfactory theory: the only certain result that I am able to arrive at is that the phenomenon does not arise from any of the causes included in the theories quoted above. It is true that the influence of these theories may exist, and they do not appear unreasonable: one may consider that they contribute, with more or less effect, to the production of the phenomena; but, according to our observations, the chief cause still remains unknown.

D. ÉGINITIS.

A Fine Perseid. Meteor from Camelopardus.

On Aug. 11 at 10^h 16^m, shortly after I had commenced watching for meteors, I saw a fine Perseid. It passed just under η Ursæ Majoris, where it left a conspicuous streak about 12° long. The nucleus flashed out strongly just prior to its disappearance, and I rated it quite as bright as Jupiter. The path was from 200° + 61½° to 206° + 44½°.

The Rev. S. J. Johnson, observing at Bridport, Dorset, saw a 1st mag. Perseid at 10^h 17½^m on the same night. It left a greenish streak and passed from slightly above α Ursæ Majoris to γ Ursæ Majoris exactly.

Mr. W. E. Besley recorded a brilliant meteor at Exeter at 10^h 15^m on same date. He estimated it to have been as brilliant as Venus. Its path was noted as from 140° + 72½° to 165° + 64°; so the apparent place of disappearance as observed at Exeter was close to α Ursæ Majoris, and agrees with the point of first appearance as recorded at Bridport.

The Rev. T. E. R. Phillips at Yeovil noted a "very bright" meteor at 10^h 17^m on the night mentioned, passing from 160° + 71° to 189½° + 45½°.

The four observations evidently relate to the same meteor, though the individual estimates of its apparent brightness differ very materially. The meteor was first seen when 92 miles vertically over a point a little N.W. of Aberdovey, and passing across Cardigan Bay it disappeared at a height of 68 miles over a point 3 miles N.N.E. of Cardigan, after a visible flight extending over 45 miles. Its earth-point was in lat. 50° 55' N., long. 6° W. The meteor had a radiant at 44° + 56°, and its direction of motion was from about N.E. by N. to S.W. by S. The duration of flight was not exactly recorded, but at Exeter and Bristol it was described as "swift" and "very swift" respectively. The heights (92 to 68 miles) determined for the meteor are decidedly above the average, but Perseids are occasionally observed with elevations, at first appearance, considerably in excess of 100 miles.

On Aug. 17 at 11^h 42^m a meteor of the 1st. mag., moving very swiftly and leaving a white streak on nearly all its course, was recorded by Prof. Herschel at Slough. It passed near the zenith, for its apparent course was from 326° + 60° to 303° + 41°. The same object was seen by the writer at Bristol, where the path seemed shorter and the motion much slower from the effects of foreshortening. It travelled over about 8 degrees, from 27° + 32° to 21° + 26½°, where it left a bright streak.

A comparison of the observations indicates that the height of the meteor at its first appearance was 71 miles over a point 10 miles N. of Slough. Moving to the S.W. it passed between Reading and Wokingham, and ended its visible career at an elevation of 56 miles over a point 5 miles N.N.E. of Basingstoke. Its whole path extended over 32 miles, and its velocity was about

43 miles per second, from an estimate of the duration by Prof. Herschel. Its earth-point was in the English Channel, about 17 miles S.S.W. of Portland Bill. The radiant was in $72^{\circ} + 52\frac{1}{2}^{\circ}$, near the star 8 Camelopardi. The shower from which this meteor was directed appears to be very well defined from the following observations :—

Date.	Radiant.	Meteors.	Authority.
1878, July 30–31....	$70^{\circ} + 50^{\circ}$	5	D. 301.
1887, Aug. 7–14....	$69 + 52$	5	D.
1889, Aug. 6–10..	$69 + 51$	6	D. 344.
1885, Aug. 10–12....	$69 + 51$	13	Kovesligethy.
1869, Aug. 13	$70 + 53$	..	Weiss.
1891, Aug. 15	$72 + 53$	5	Booth.
1884, Aug. 21–26....	$70 + 50$	11	D. 448.

The mean position is at $70^{\circ} + 51\frac{1}{2}^{\circ}$. There is also a well-marked shower from this point in October.

Bristol, 1898, Aug. 23.

W. F. DENNING.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Aristarchus of Samos and Posidonius.

GENTLEMEN,—

The earliest attempt made to determine the approximate distance of the Sun was presumably that of Aristarchus, who, from observation of the angular distance between the Sun and Moon when the latter was dichotomized (a time which must be very difficult to fix), concluded that the distance of the Sun from us was more than eighteen, but less than twenty, times that of the Moon. The angle in question he considered to be $\frac{3}{8}$ of a right angle, or about 87° . The error in this determination, says Proctor, in the 9th edition of the 'Encyclopædia Britannica,' under "Astronomy" (vol. ii. p. 748), "is very considerable, the true angle being about $87^{\circ} 50'$." I presume this is a misprint, and that Proctor really wrote $89^{\circ} 50'$, and cannot help expressing my regret that the 'Times' should have recently reprinted this edition of the 'Encyclopædia' without correcting the casual misprints, of which so large a work must have a considerable number, and I have indeed myself had occasion to point out several at different times in the columns of 'Notes and Queries,' besides one, on Astrology, in the 'Observatory' for September 1897 (vol. xx. p. 350).

Aristarchus goes on to determine approximately the relative sizes of the Sun and Earth, from the fact that the apparent diameter of the Sun, like that of the Moon, is about the 720th

part of the circumference of the sphere, or half a minute of arc. His conclusion is that the proportion of the Sun's diameter to that of the Earth is more than that of 19 to 3 ($=6.33$), and less than that of 43 to 6 ($=7.17$), and that the proportion of their volumes is more than that of 6859 to 27, and less than that of 79507 to 216; *i.e.* that the bulk of the Sun would contain that of the Earth something between 254 and 368 times.

So far Aristarchus. But how did Posidonius obtain his much more accurate knowledge or conjecture respecting the true distance of the Sun? From that philosopher Cicero seems to have derived many of his ideas, and it is great matter of regret that none of his works have come down to us. All we know on the above point is from the report in Pliny, who says ('Nat. Hist.' ii. 21) that Posidonius had found that the Moon was distant from our atmosphere two million stadia, and that the distance from thence to the Sun was five hundred million stadia, numbers which are astonishingly near the truth. Narrien remarks ('Historical Account of the Origin and Progress of Astronomy,' p. 207) that they "could only have been brought out by some fortunate chance arising from a compensation of errors." A manuscript of Posidonius would be a find of very great interest to astronomers.

Yours faithfully,

W. T. LYNN.

Blackheath, 1898, Aug. 2.

Sunset from a Legal Point of View.

GENTLEMEN,—

There is certainly a fine opportunity for a wealthy and enthusiastic cyclist to contest this point, and have it carried from successive tribunals to the House of Lords, where no one could venture to anticipate its fate.

The law enacts that such a thing must be done at (or before) sunset, that is, at the time when the Sun sets. According to all the laws of language this must mean when the Sun sets at the place where the event in question occurs. But (as Mr. Chambers tells us) a previous Act of Parliament defines time to be Greenwich time for an event in any part of Great Britain. Hence, in order to comply with this Act, it is necessary first to ascertain the local time of sunset according to the latitude (longitude would not affect this), and then apply the longitude so as to convert this into Greenwich time.

In actual words this seems perfectly clear. But then comes the question of going behind the words to the *animus imponentis*. No doubt the legislature considered they were giving a wide margin in the matter (as it does not usually become dark until a considerable interval of time after sunset), and then, to avoid the necessity of calculating the actual time of local sunset, thought it would suffice to adopt for use the Greenwich time of sunset as given in the almanacs, which is, of course, the Greenwich time of

sunset at Greenwich. The statute as worded necessitates not less, but more calculation than if time had been taken in its natural signification of local time.

Yours faithfully,

Blackheath, 1898, Aug. 8.

W. T. LYNN.

Dark Elliptical Spots in the North Tropical Zone of Jupiter.

GENTLEMEN,—

In continuation of my letter in the 'Observatory' for May, p. 205, on the above interesting objects, I beg to send the following observations obtained since April 18 last, by Mr. A. Stanley Williams of Brighton, the Rev. T. E. R. Phillips of Yeovil, and by myself at Bristol:—

Spot A.			Spot R.			Spot C.		
	λ.	Obs.		λ.	Obs.		λ.	Obs.
1898			1898			1898		
Mar. 20 ...	129°6	W.	Apr. 19 ...	254°7	P.	Mar. 21 ...	310°0	W
22 ...	126°0	W.	22 ...	250°8	D.	31 ...	305°6	W
29 ...	124°0	W.	24 ...	254°3	D.	Apr. 5 ...	301°9	W
Apr. 6 ...	123°2	W.	May 6 ...	249°9	D.	12 ...	301°4	W.
8 ...	122°6	W.	6 ...	251°1	P.	17 ...	298°6	W.
13 ...	119°5	W.	15 ...	246°2	P.	19 ...	300°1	W.
15 ...	119°8	W.	18 ...	244°1	P.	22 ...	294°9	D.
23 ...	117°4	W.	18 ...	246°3	D.	22 ...	294°8	W.
25 ...	119°6	P.	June 11 ...	235°4	P.	29 ...	294°9	D.
30 ...	114°1	W.	30 ...	230°2	P.	May 4 ...	294°6	P.
30 ...	118°1	P.	July 5 ...	230°6	D.	6 ...	292°2	W.
May 12 ...	112°0	D.	17 ...	222°6	D.	6 ...	292°9	D.
12 ...	114°9	P.				6 ...	294°6	P.
24 ...	108°7	W.				11 ...	293°3	P.
31 ...	106°6	P.				16 ...	290°7	P.
June 5 ...	104°0	P.				16 ...	290°7	D.
10 ...	103°8	P.				18 ...	287°0	P.
10 ...	105°3	D.				18 ...	287°5	D.
17 ...	100°3	P.				23 ...	285°8	P.
22 ...	98°4	D.				28 ...	281°8	D.
22 ...	100°9	P.				28 ...	283°8	P.
July 4 ...	94°9	D.				June 4 ...	281°4	P.
4 ...	96°7	P.				11 ...	277°1	P.
						11 ...	279°2	D.
						16 ...	275°9	P.
						16 ...	277°1	D.
						28 ...	274°9	D.
						28 ...	274°9	P.
						30 ...	272°5	P.
						July 3 ...	271°7	D.
						5 ...	269°9	D.
						10 ...	269°3	P.
						10 ...	269°8	D.
						17 ...	264°6	D.

Comparing the terminating observations of each series with the opening ones obtained by Brenner and Fauth ('Observatory,' p. 205), the three markings appear to have been moving at the following rates:—

Spot.	Limiting dates of observation.	Length of interval in days.	Drift to west.	Daily rate.	Rotation period. h m s
A	Jan. 20-July 4	165	47 ^o 8	0 ^o 290	9 55 28 ^o 7
B	Nov. 25-July 17	234	82 ^o 4	0 ^o 352	9 55 26 ^o 2
C	Nov. 25-July 17	234	95 ^o 4	0 ^o 408	9 55 23 ^o 9

The mean period of rotation of the three objects has been 9^h 55^m 26^s.3, or 14^s.3 less than the period on which System II. in the ephemerides is based. My own observations of the spots give a mean period of 9^h 55^m 26^s.3, which is identical with the above, the figures being :—

Spot.	Limiting dates of observation.	Rotations.	Period. h m s
A	March 23-July 4	249	9 55 27 ^o 7
B	April 17-July 17	220	9 55 26 ^o 3
C	March 14-July 17	302	9 55 24 ^o 8

These individual results, while corresponding in the mean value with the observations previously alluded to, yet exhibit more equable rates for the three spots. In explanation of this it appears very probable that in the early part of the past opposition the differences of motion in the objects were really greater than during the latter part.

It is perfectly well assured, from a number of independent observations, that in different longitudes the same Jovian current exhibits very marked differences of velocity. And the mean rate is sometimes found to vary with the appearance of new spots ; nor does it remain consistent during the whole period of their presentation. In the autumn and winter of 1894-95 I determined the mean rate of the current in about Lat. +15° as 9^h 55^m 35^s, from observations of 9 spots ('Monthly Notices,' vol. lv. pp. 475-77). In the following season of 1895-96 the "violin" and "garnet" spots showed that little disturbance had taken place, their periods being 9^h 55^m 33^s.8 and 9^h 55^m 32^s.6 respectively ('Observatory,' vol. xix. p. 327). But under certain physical influences the velocity of this current has recently been accelerated to the extent of about 9 seconds as compared with its rate in 1894-95.

Yours faithfully,

Bristol, 1898, Aug. 16.

W. F. DENNING.

The Solar Physics Committee.

GENTLEMEN,—

I very earnestly hope that the paragraph which you quote from 'Truth' on p. 322 will meet the eye of Lord Balcarras, to whose acumen, pluck, and pertinacity in connection with the recent exposures at South Kensington, everyone having the interest of British scientific purity and morality at heart is so deeply indebted.

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2 F

It is not so long since the Council of the Royal Astronomical Society was expressing indignation that it had not been consulted prior to the adoption of certain constants in the 'Nautical Almanac' for 1901. I have not, so far, heard that it has made any protest against the wicked waste of money involved in the perpetration of the barefaced and impudent job which Mr. Labouchere has brought to light.

If we claim that we should be the advisers of the Government on astronomical subjects, why do we sit still and suffer the public pocket to be picked in this fashion for the private pecuniary benefit of any person or persons upon a pseudo-scientific pretext?

Forest Lodge, Maresfield, Uckfield,
1898, Aug. 22.

Yours faithfully,
WILLIAM NOBLE.

OBSERVATORIES.

NATIONAL OBSERVATORY, PARIS.—Among the hard details of facts and figures which generally make up the report of the work of a Government Observatory, there is sometimes found some statement of a general nature which records a special advance made in the history of the science. The *clou* of Mr. Loewy's report for the year 1897 is contained in his remark that the arrangement of the meridian work has been reorganized, the reason for which may be taken as marking an epoch in this particular branch.

The staple work of the Paris Observatory for more than forty years past has been the re-observation of the stars contained in Lalande's Catalogue. The results of this work are contained in the huge Paris Catalogue, of which three volumes out of four have already appeared. It is hoped that the whole work will be completed in two or three years, so that, as practically all the observing is done, it was necessary for the Director to select a new line of work. In doing this Mr. Loewy realized that a new era in astronomy has opened, and that the progress in different branches which has been going on during the past twenty years has quite modified the conditions of work. Photography particularly has given us a method by which the relative positions of stars can be determined with great facility and in great number, so that the purposes to which meridian instruments should be now devoted would seem to be the determination of the absolute places of stars to be used as fundamental for photographic catalogues and to researches in geometrical astronomy of the highest degree of precision.

With such ends in view, it is necessary to have not only instruments of the highest quality, but also astronomers to use them of the highest capability. Mr. Loewy in effect states his opinion that the work of the meridian observer has hitherto not received the credit that it deserves in comparison with other work more showy,

but demanding no more skill; and also that the plan hitherto in operation, whereby a number of observers have collaborated in effecting some piece of meridian work, has, by paralyzing individual enterprise, not conducted to the highest standard of excellence of work. Bearing these things in mind, M. Loewy has rearranged his staff so that each member may have the responsibility and possible honour for the work he does. The Meridian Circle *du jardin* has been entrusted to MM. Renan, Perchot, and Ebert, who will use it to make a determination of absolute latitude and the variation of the same. The great meridian instrument has been put under the care of MM. Oltramare and Lancelin, who, assisted by M. J. Chatelu, will make determinations of absolute declination of fundamental stars, and the two Gambeys instruments, in the hands of M.M. Barré, Viennet, and Brandicourt, will for a time be used for making the remaining observations necessary for the completion of the Paris Catalogue above mentioned. As a preliminary to work of high precision, such as it is hoped may be done with these instruments, some improvements have been introduced, a new set of microscopes for the circle *du jardin*, new meridian marks, and electric lighting for the marks and instruments. Other necessary improvements will be made when the funds are forthcoming.

The new arrangement took effect from 1897, March 1. With the Great Circle the first proceeding was to make an enquiry as to the cause of certain marked daily and hourly variations of the reading for the nadir. The instrument was overhauled, the object-glass fixed more firmly, the microscope screws re-fitted, and new eyepieces, which would come to focus more readily, were supplied. After these improvements it was found that variation from hour to hour, similar to that noticed at Greenwich, still exists, but the change from day to day was much less. The actual work to which this instrument is now devoted was begun, but naturally, at present, it is impossible to state any result except that a great many observations have been made.

Since taking charge of the meridian instrument *du jardin*, M. Renan and his two collaborators have made investigations of the instrumental constants, the reading for nadir, and the flexure of the instrument. The chief conclusion arrived at appears to be that one great cause of error in meridian observing is the adjustment of the focus: a special method has been adopted to make this adjustment effectually. A zenithal mirror, floating in an annular bath of mercury, according to M. Deichmüller's principle, has been constructed for observation of the nadir.

With the Gambeys instruments, 3777 observations have been made with the transit, and 3764 with the circle.

Equatorials.—The great equatorial *coudé* was used during the year to continue the formation of the Photographic Atlas of the Moon. The few plates which have been added to the Atlas (it appears that only two nights' work were considered good) are out

of all proportion to the whole number taken, for Mr. Loewy is only satisfied with results of a very high standard. An excellent photograph of the 4-day old Moon forms a frontispiece to the Report. The small *coudé* instrument was used by M. Hamy during the first part of the year to make trial of a method proposed by M. Fizeau to measure small diameters.

When the object-glass of a telescope is covered by a screen in which are cut two straight, equal, and parallel slits, star-images are seen at the focus of the instrument in the form of bands alternately bright and dark. This phenomenon is due to the interference of two luminous pencils which pass through the slits. The sharpness of the fringe is not generally perfect, when the luminous source has a sensible angular diameter. It happens even that the maxima and minima of the intensity of the image disappear, and give place to a uniform brightness when the slits have a suitable separation, which is a function of the diameter. The application of this principal might enable the diameter of a small object to be measured by determining the distance between the slits corresponding to the vanishing of the fringes.

In practice this method appears to be somewhat difficult, and no results are given.

With the western equatorial, as in former years, occultations of stars, phenomena of Jupiter's satellites, and positions of comets and small planets were observed. The programme with this instrument for the current year, 1898, includes a determination of the constant of aberration by Loewy's method, which will be welcomed. The equatorial in the eastern tower has been used for micrometer observations of double stars and small planets as previously.

The Astrographic Chart.—Seventy-four Catalogue plates were taken during the year, which completes the series except for a few isolated plates, necessarily omitted through circumstances beyond control. For the Chart 36 plates were taken. As to the measurement of the catalogue plates, the plan of measuring them a second time, reversed in the micrometer for elimination of personal equation, has been adopted, and 77 plates have been measured during the year in both positions. Altogether 33,192 stars have been measured. Forty-three plates were reduced, so as to show the Right Ascension and Declination of the 18,762 stars on them.

Eighteen Chart-plates have been reproduced by heliogravure.

As to the Spectroscopic work, which is under the direction of M. Deslandres, the work done by day was the photography of the solar chromosphere, which is effected by means of a Foucault siderostat. The object-glass of 0^m.12 aperture, formerly used with this, has been replaced by a larger one of 0^m.30 aperture and 5^m focal length, which gives an image of the Sun of 0^m.087 diameter. These photographs of the chromosphere, it is stated, are the largest that have yet been taken.

Besides this work on the Sun, the great reflector of 1^m.20 diameter has been used, with a three-prism spectrograph, to determine velocity of stars in the line of sight, and 47 successful plates have been taken. In the laboratory, besides the examination of

these solar and stellar plates, M. Deslandres is making a research on the subject of cathode rays, which, he thinks, are not unconnected with the coronal streamers, and may lead to an explanation of the cause of comets' tails.

PUBLICATIONS.

IN Nos. 3508-9 of the '*Astronomische Nachrichten*' Dr. Auwers gives provisional corrections to the position of the stars of the Fundamental Catalogue of the *Astronomische Gesellschaft* for the years 1880 and 1900, and new values of the proper motions of these stars. This work is a first step in the construction of the new fundamental catalogue on which Dr. Auwers is engaged, and only gives the detailed corrections to the various stars, but no general corrections to the system. In its preparation Dr. Auwers has used all observations since Bradley's time which have any claim to consideration and which are generally accessible down to the most recent observations at Greenwich, the Cape, Paris, Pulkova, and Washington. The provisional weighting which has been adopted is of interest in one particular—observations before 1820 having a relative weight of 1, those between 1820 and 1860 of 2, and later observations of 3. Although these corrections are not to be taken as the final internal corrections which the A. G. Fundamental Catalogue requires, it may be taken that no serious alterations will be made.

Dr. Auwers remarks on the value of Bradley's observations that, though they cannot be considered as of great value for the "*Orientirung*" of the system of fundamental Right Ascensions and Declinations—though as good for this purpose as any other observations made before 1815 or 1820—they are nevertheless of the greatest value in the determination of the proper motions of individual stars. He instances cases in which Piazzi and Groombridge differ largely, possibly through errors of computation or of printing in one of the Catalogues, where the existence of earlier observations makes it possible at once to discriminate which of the two Catalogues is in error.

The corrections to the proper motions of the Bradley stars are, generally speaking, very small (in 20 cases they are more than 0".0005 in R.A., and in 29 cases more than 0".005 in N.P.D.); a short list is given of those stars which have required the greatest corrections, and the causes of the previously erroneous values.

In the case of two stars the possibility of an orbital motion has been detected. π Boötis shows in both co-ordinates indications of a period of 100 years, and γ Draconis shows in R.A. a period of 90 years, though the latter may be possibly due to some accumulation of errors in the observations from 1805 to 1830. F. W. D.

OBSERVATIONS OF MARS IN 1896-97.—Between February 1896 and May 1897 Herr Brenner obtained 73 drawings and some sketches of Mars *. Eighteen of these drawings are given in the memoir describing the results of the observations, together with a map of the planet resulting from all the drawings and sketches. The opposition took place on the 10th December, and Mars was therefore not particularly well situated as regards distance from the Earth; but, on the other hand, both poles could be observed: first, the south one until the equator was placed centrally across the disk on the 24th September, after which the north pole came into view. The southern snow-spot reached at first as far as 50° latitude, and had quite disappeared by the beginning of September; but whether all the snow had actually melted was uncertain, as the south pole then receded from view. In the beginning of May 1897 the north polar spot had spread to 56° latitude; but it was bordered by an exceedingly irregular line, which in longitude 357° even came down to 44° latitude.

Naturally the greater part of the paper is devoted to a list of the 165 canals seen in the course of the observations. Among these are 88 of Schiaparelli's and 9 of Lowell's. Of the remaining 68, fifteen were seen by Herr Brenner already in 1894, and others are identical with some seen but not named by Schiaparelli, or were afterwards found to occur in his fifth memoir, while some are perhaps identical with canals seen by Lowell, and by him erroneously supposed to be identical with certain of Schiaparelli's canals. Unless the positions of these difficult objects are fixed with the greatest care, it is obviously impossible to identify those seen by different observers with certainty, as even the most conspicuous of them are never seen all at the same time. Of the 44 canals which, on Mr. Lowell's map are seen to cross the seas of Mars, and for which Mr. Douglass alone is responsible, none were seen by Herr Brenner. The map shows a wonderful network of canals, and is in some parts even more crowded than Mr. Lowell's map. Some of the "lakes," from which numerous canals radiate, are larger than we remember having seen them on any other map.

A more detailed memoir on the same opposition has lately been published by Signor Cerulli †. His observations were made with his $15\frac{1}{2}$ -inch Cooke refractor, from May 1896 to March 1897, and include determinations of the positions of sixty well-defined spots. The map prepared from the observations does not contain nearly as many canals as Herr Brenner's, but is more artistically finished, giving the proper contrast between easy and difficult objects. The concluding paragraph is devoted to considerations on the nature

* Mars-Beobachtungen 1896-97 auf der Manora-Sternwarte in Lussin Piccolo. Von Leo Brenner. Anhang zu den Abhandl. der k. Preuss. Akad. der Wissenschaften, 1897. Berlin, 1898, 30 pp. 4°. With 3 plates.

† Pubblicazioni dell'Osservatorio privato di Collurania (Teramo), No. 1. V. Cerulli: Marte nel 1896-97. Con 3 tavole. Collurania, 1898, 126 pp. 8°.

of the canals. Signor Cerulli remarks that the canals were almost as broad in July 1896, when the disk of Mars was 7" in diameter, as in the following December when the diameter was 17", while lines seen dark and distinct at some distance from the centre were fainter and narrower when the rotation had brought them to the middle of the disk. From these circumstances he doubts that the canals are actual features on the surface of Mars, and points out that our best telescopes hardly show us as much of this surface as an opera-glass shows us of the Moon, on the face of which an opera-glass indeed seems to show some lines which are nothing but the borders of darker parts of the surface, and which disappear when a higher power is used. That this explanation should altogether account for the multitude of lines on Mars may, however, well be doubted, though it may perhaps account for the streaks seen by some observers on Venus, Mercury, and Jupiter's third satellite.

J. L. E. D.

THE RUTHERFURD PHOTOGRAPHIC MEASURES *.—In these days of stellar photography there is an obvious danger of the prevalence of the much-condemned practice of making accumulations of observations without any attempt at their reduction. Remembering this, some commendation is due to the astronomers of Columbia University, New York, who devote themselves to reducing and publishing the results of the earliest efforts in astronomical photography—those by Lewis Rutherford taken some thirty years ago. A small volume recently distributed from this Observatory consists of three researches of this kind by Mr. and Mrs. Herman S. Davis. Among the Rutherford photographs there were 19 of the region about the pair of stars 61 Cygni, which were measured by Miss Ida Martin more than twenty years ago, to show distance and position-angle with the principal star as origin. These measures have been reduced by applying appropriate corrections for refraction, aberration, scale value, &c., to convert them into differences of right ascension and declination. By applying these to the place of 61¹ Cygni given in Auwers's Fundamental Catalogue, a catalogue of 65 stars has been formed.

The next section of the book (Contribution No. 13) is a deduction of the Parallax of 61¹ Cygni from the same data; pairs of stars from the above 65 were chosen that their components should be as nearly as possible equally distant from 61¹ Cygni and different 180° in position-angle. These pairs, five in number, were used as comparison stars, and from the variation of their distance from the principal star its parallax was deduced; and not only were measures of distance used for this purpose, but the parallax was also deduced from measures of position-angle of seven stars, which

* 'Contributions from the Observatory of Columbia University, New York,' Nos. 12, 13, and 14.

Mr. Davis thinks is a perfectly trustworthy method. The results arrived at seem to justify this :—

$$\begin{aligned} \text{Parallax from distance measures} &= +0''.3999 \pm 0''.0230. \\ \text{,, ,, pos.-ang. ,,} &= +0''.3326 \pm 0''.0189. \end{aligned}$$

The adopted mean of these $+0''.360$ is rather smaller than Pritchard's determination of the same quantity, against which research it may be remarked Mr. Davis brings a grave charge of inaccuracy, but agrees within $0''.01$ with the mean of six other determinations. The measures of the close star 61^2 Cygni give a value of its parallax less by $0''.072$ than the parallax of 61^1 , which is in such agreement with previous determinations as to leave little doubt as to the reality of the difference of parallax of the two stars. So that if 61^1 Cygni be really a binary system of which one member is a dark body, as has been suggested, it is nevertheless far removed from the influence of 61^2 Cygni, which would account for the fact that the orbital motion of 61^1 and 61^2 about a common centre of gravity is as yet unproved.

The third section of the book is the reduction by Mrs. Davis of the measures of thirty-four stars near Bradley 3077 by methods similar to those adopted for the group about 61 Cygni as above described. The positions of the resulting catalogue depend on Argelander's position and proper motion of the principal star.

A USEFUL reprint of three articles in the 'Astrophysical Journal' (1897 October, December, 1898 January), on "Helio-graphic Positions," by Mr. F. W. Very, has been issued*. Although this contains nothing particularly original, it may be found useful by anyone engaged in making researches on sun-spot positions, as it collects in a convenient form the geometrical facts and formulæ relating to the subject, and gives hints on observing, as well as the lines on which such researches should proceed.

NOTES.

COMET NOTES.—Perrine's Comet of March last (*b* 1898) was still observable at the Lick Observatory in the middle of July, and as the brightness was only slowly diminishing it will probably be visible for some time longer.

Herr K. Pokrowskij has computed the following elliptical elements from observations extending from March 21 to May 21 (Ast. Nach. 3510):—

* University of Chicago Press, 1898.

T.....	1898 March 17.1124	Berlin M.T.
ω	47° 15' 4"	} 1898.0.
Ω	262 24 37	
i.....	72 32 45	
log q ..	0.03920	
log e ..	9.98978	
Period..	322.6 years.	

The comet passes within a distance of 1.3 of Jupiter's orbit. This may be the cause of the ellipticity of the orbit, which now seems placed beyond doubt.

Ephemeris for Berlin midnight.

R.A.			N. Dec.			R.A.			N. Dec.		
h	m	s	°	'	"	h	m	s	°	'	"
Sept. 7....	6	32	14	50	51	Oct. 17....	6	19	9	50	20
15....	6	34	15	50	41	25....	6	9	14	50	8
23....	6	34	4	50	35	Nov. 2....	5	57	8	49	46
Oct. 1....	6	31	33	50	30	10....	5	43	17	49	12
9....	6	26	37	50	26	18....	5	28	22	48	23

Brightness 0.05 on Sept. 7, 0.04 on Nov. 18.

The following improved elements of Comet Coddington-Pauly have been deduced by E. Millosevich from observations extending from June 14 to July 3 (Ast. Nach. 3510):—

T.....	1898 Sept. 13.818	Berlin M.T.
ω	232° 58'.0	} 1898.0.
Ω	73 59.5	
i.....	70 3.6	
log q	0.23214	

Ephemeris for Berlin midnight.

R.A.			S. Dec.			R.A.			S. Dec.		
h	m	s	°	'	"	h	m	s	°	'	"
Sept. 1....	13	35	33	55	53	Sept. 17....	13	39	22	60	53
5....	13	35	38	57	4	21....	13	41	47	62	15
9....	13	36	19	58	18	25....	13	44	49	63	41
13....	13	37	33	59	34	29....	13	48	32	65	10

Brightness 0.59 on Sept. 1, 0.48 on Sept. 29.

The following elements and ephemeris of Comet ϵ 1898 (Perrine) are by Mr. Perrine, from observations on June 17, 24, July 1:—

T.....	1898 Aug. 16.239	G.M.T.
ω	205° 12'.3	} 1898.0.
Ω	259 10.3	
i.....	70 0.2	
log q ..	9.8002	

Ephemeris for Greenwich midnight.

	R.A.			S. Dec.				R.A.			S. Dec.		
	h	m	s	°	'	"		h	m	s	°	'	"
Sept. 2....	9	32	51	13	13		Sept. 22....	11	14	13	32	27	
6....	9	52	26	17	52		26....	11	34	41	35	3	
10....	10	12	32	22	9		30....	11	54	50	37	16	
14....	10	32	58	26	1		Oct. 4....	12	14	32	39	9	
18....	10	53	36	29	27		8....	12	33	38	40	46	

Brightness 6·7 on Sept. 2, 1·6 on Oct. 4.

The following elements and ephemeris of Comet *g* 1898 (Giacobini) are by Dr. A. Stichtenoth from observations on June 19, 29, July 18 (*Ast. Nach.* 3511):—

T	1898 July 25	5505	Berlin M.T.
ω	22°	24'	35"
Ω	278	17	10
i	166	51	1
log q	0·17646		

} 1898·0.

Ephemeris for Berlin midnight.

	R.A.			S. Dec.				R.A.			S. Dec.		
	h	m	s	°	'	"		h	m	s	°	'	"
Sept. 2....	13	35	9	1	58		Sept. 14....	13	34	6	1	40	
6....	13	34	34	1	51		18....	13	34	7	1	36	
10....	13	34	14	1	45								

In Javelle's elements, given last month, the quantity printed log q is really q .
A. C. D. C.

MINOR PLANET NOTES.—Two new planets have been discovered: the first (DP) by Charlois, at Nice, on July 16; the second (DQ) by Witt, at the Urania Observatory, Berlin, on Aug. 14. They are both of the 11th magnitude. DQ was retrograding in R.A. at the rate of 2 min. per day; it is probably one of the nearer members of the family.

'Bulletin Astronomique' for July contains a review by M. Callandreau of a large number of recent works on the perturbations of minor planets. He concludes by saying:—"The solution of the problem proposed by the Academy of Sciences leaves no longer much to be desired, thanks to the work of MM. Harzer, Bohlin, Simonin, Brendel, Backlund, &c. Perhaps it will be possible to simplify it a little giving a larger place to numerical methods. The revision of the principles of the 'Mécanique céleste' was useful; but now the theoretical study of the movement of fictitious bodies treated as simple material points does not correspond to the case of Nature. Astronomers should anticipate the intervention of other actions, of which the resisting medium has offered the first example: the reconciliation of theory and observation should remain their principal endeavour."

The August number of the 'Bulletin' contains a paper by M. Mascart on the probability of the coincidence of the elements of two planets. His work tends to the conclusion that the number of close approaches of the orbits of minor planets is not greater than the laws of probability suggest, that Jupiter has no influence in producing these approaches, and that they appear to favour certain regions of the zone more than others, these not being always the most crowded regions. A. C. D. C.

THE EXTERIOR NEBULOSITIES OF THE PLEIADES.—We have received the following from Prof. E. E. Barnard, of the Yerkes Observatory:—"Through the kindness of Dr. H. C. Wilson, of Northfield, Minn., I have a copy—a lantern-slide—of a photograph of the Pleiades made by him with a 6-inch Brashear portrait-lens. This picture shows well the exterior nebulosities of the group, just as shown in my photographs, and even stronger. The exposure was 11 hours.

"I forward a negative print from a lantern-slide of Dr. Wilson's picture and from my own, for inspection, but not for reproduction, for the prints would suffer too much from the ordinary method of reproduction. It will be seen that in several cases the nebulosity has been brought out stronger on Dr. Wilson's plate—the exposure being $\frac{3}{4}$ hour longer."

It will be remembered that the above has reference to a controversy between Dr. Roberts and Prof. Barnard as to the existence of a nebulosity surrounding the Pleiades. Prof. Barnard some years ago published in the *Ast. Nach.* a description of wisps of nebulæ which he had detected on a photograph of the Pleiades group, from which he inferred that the system is wholly involved in a scattered nebulosity of which there are knots here and there surrounding some of the brighter stars. Dr. Roberts, on the contrary, from the evidence of his photographs, admits only the existence of the knots, and suggests that the surrounding wisps are photographic effects. We have examined the two pictures Prof. Barnard has sent, one taken by Dr. Wilson and one by himself; the coincidence in position of the wisp-like markings on two independent photographs affords strong evidence as to the reality of their existence.

SIR JOHN HERSCHEL'S HOUSE AT FELDHAUSEN.—It may not be generally known (it was not known to us until we recently received the copy of the address referred to below) that the house and grounds which Sir John Herschel occupied when he made his renowned observations at the Cape are now used for purposes of the Diocesan College. Mr. Gordon, a grandson of the astronomer, has presented a portrait of Sir John to the School, and on June 23 last the ceremony of uncovering this was performed by Dr. Gill, H.M. Astronomer at the Cape, who delivered an eloquent address, with the subject of the picture as his text. After giving

a short description of Herschel's life and work Dr. Gill went on :—

I have said that Herschel was an accomplished chemist, but to many present it is probably unknown that this great quondam occupant of Feldhausen was one of the fathers of photography, and was certainly the first to produce a photographic picture on glass. I have brought with me, for exhibition to-day, a copy from what I understand is the first photographic picture ever taken on glass. It was presented to the Cape Observatory by the Herschel family. It is framed in a portion of the woodwork of the stand of Sir William Herschel's 40-foot reflecting telescope, and represents that instrument as photographed by Sir John Herschel in the year 1839. I need hardly dwell at greater length on Sir John Herschel's life and labours. Few men who have ever lived possessed more splendid intellect and imagination, and greater or more poetic power in expressing the deepest thought. He was the prose poet of science, his popular scientific works are models of clearness, and his presidential addresses teem with passages of surpassing beauty. His life was a pure and blameless one from first to last, full of the noblest effort and the noblest aim from the time when as a young Cambridge graduate he registered a vow "to try to leave the world wiser than he found it"—a vow that his life amply fulfilled. He died in 1871 at the age of seventy-eight, full of years and full of honours, and a grateful nation accorded his remains a resting-place in Westminster Abbey beside that of England's greatest scientist, Sir Isaac Newton. Such was the man who lived and did such memorable work at Feldhausen. He was unquestionably the greatest man that has ever lived in South Africa, and it behoves us to keep his memory green.

But there is an obelisk in the grounds erected to Herschel's memory in the place where his telescope stood; and later on in his speech, referring to this, Dr. Gill remarked, with much concern, how little was known of Herschel; in fact how he was almost unknown by the present occupants of the house. We were surprised to read, as surprised as Dr. Gill evidently was to hear, that the obelisk gives rise to the question "Who was Herschel?" Astronomy and astronomers do not occupy a large part of the world's attention, but we should have thought that if the average person had been asked to give the name of a famous astronomer, in three cases out of four the answer would have been "Herschel," although there might be no attempt at distinguishing between the father and son; but it may be that a generation is arising to whom the name of the famous family is unfamiliar. Dr. Gill, in his usual practical way, tried to obviate this by suggesting that the day when Herschel made his first observation at the Cape, February 22, should be held in special honour as "Herschel's Day" at the School.

A SPECTROSCOPIC METHOD OF DETERMINING THE PARALLAX OF BINARY STARS.—It is not difficult to understand, without going into great detail, that there is a numerical relation between the relative velocity of the components of a binary system, its parallax, and the elements and apparent size of its orbit. Accurate formulæ on the subject have been given by Prof. Niven in the 'Monthly Notices' for May 1874, and by Dr. Rambaut in the issues of the same publication for March 1890 and March 1891. It would

em, then, that as it is possible to determine the relative velocity of the components by the usual spectroscopic method for measuring velocity in the line of sight, we have here a convenient method for determining parallax. This in theory is actually the case; but practically the method has not been tried until recently, because the relative velocity of most well-known telescopic binaries is too small to be satisfactorily measured by the spectroscope. But now Dr. Belopolsky has made the attempt and has used the 30-inch refractor of the Poulkova Observatory to observe the relative velocity of the components of γ Virginis and γ Leonis. The account of the application of his results as data is given in *Astr. Nach.* No. 3510.

In 1897, April, he measured the velocity of the northern component of γ Virginis in the line of sight, relative to the Sun, to be 13.49 English miles per second (receding), and the similar velocity of the southern component to be 12.21 English miles per second (receding). Combining this relative velocity (12.8 miles per second) with Doberck's elements of the orbit, Dr. Belopolsky deduces that the parallax of γ Virginis is 0".051, that the combined mass of the system is 15 times the Sun's mass, and that the velocity of the system in the line of sight from the Sun is 12.86 English miles per second.

In the case of γ Leonis the observations of the brighter star made at Potsdam were used. These, combined with those made by Dr. Belopolsky, showed that its velocity in the line of sight, with respect to the Sun, is 24.53 English miles per second (receding). The Poulkova measures of the fainter component gave a velocity of 23.19 miles (receding), and the combination of this relative velocity of 1.34 miles (approaching) with Doberck's elements of the system give a parallax of 0".0197; combined mass = 6.5 times the Sun's mass, and a velocity of the system in the line of sight of 23.88 English miles per second, relative to the Sun. The method at present is not of sufficient precision to give much confidence in the accuracy of the fourth decimal place; but Dr. Belopolsky is to be congratulated on a successful attempt to apply an ingenious method for the first time.

RETARDED SUMMER WEATHER.—After a succession of cold months in May, June, and July, which appeared to support the theory advanced by many meteorologists of a nineteen-years' weather cycle, the weather in the month of August (after three or four cold days) became exceptionally warm and summer-like, the mean temperature for the 15 days August 11 to 25 being in excess of the average by as much as 7°.1. The highest point reached by the thermometer was 90° on the 22nd of August, whilst in July it never exceeded 82°. On the 13th, 14th, 15th, and 22nd the mean daily temperatures exceeded their corresponding averages by 11°, 10°.2, 12°, and 11° respectively. Warm nights were also characteristic of the period, the lowest night temperature on the 13th

having been $64^{\circ}2$, on the 15th $64^{\circ}3$, and exceeding 60° on three other days. Nocturnal temperatures exceeding 64° are very rare in August, there having been only three such temperatures recorded in the preceding 57 years, viz., $64^{\circ}4$ on 1842 August 19, $64^{\circ}3$ on 1846 August 1, and $66^{\circ}8$ (the highest on record) on 1893 August 18. Rain still continues to be deficient, the rainfall having been very small in the months of June, July, and August—the total amount of deficiency in the eleven months from October 1897 to August 1898 being 7·8 inches.

THE ORBITAL MOTION OF PROCYON.—Dr. See gives in 'Astronomical Journal,' No. 440, a very exhaustive and interesting account of Procyon and its companions. By help of the observations of the two distant companions he determines the motion of the principal star. He deduces its orbit, and also the relative orbit of the Schaeberle companion, as follows:—

	Orbit of Procyon.	Relative Orbit of Companion.
P	40 years.	40 years.
T	1891·0	1891·0
e	0·45	0·45
a	0·94	5·84
ω	$108^{\circ}3$	$108^{\circ}3$
γ	$33^{\circ}13$	$33^{\circ}13$
λ	286·35	106·35

An ephemeris is computed and the places of the companion compared with recent micrometric measures. The agreement is very close.

Assuming the present distance to be $4''\cdot80$, the masses are in the exact ratio 1:5. If Elkin's parallax $0''\cdot266$ be adopted, the semi-axis major of Procyon's orbit is 3·534 astronomical units; and as the semi-axis major of the relative orbits is six times as large, or 21·2 units, we see that the dimensions of the orbit of the companion slightly surpass those of the planet Uranus.

The combined mass is 5·955 that of the Sun and Earth, and hence the companion is almost exactly of the same mass as the Sun.

A SUPPOSED NEW STAR IN ANDROMEDA.—Mr. A. A. C. Merlin, who is British Vice-Consul at Volo, Greece, and also an amateur astronomer, telegraphs under date August 29, that he has observed a star very near the nucleus of the nebula in Andromeda. The object was evidently not bright, as Mr. Merlin states that it is *visible in an 8-inch refractor*. A photograph taken at Greenwich with the Astrographic Telescope on August 31 showed nothing unusual. The appearance of a temporary star in the nucleus of this nebula from 1885 September 1 to December of the same year will be remembered.

NEPTUNE AND HIS SATELLITE.—From the excellent series of measures of the satellite of Neptune made by Prof. Barnard with the Yerkes telescope it has been possible for Prof. Asaph Hall to determine corrections to the elements of its orbit. The mass of Neptune compared with that of the Sun deduced is $\frac{1}{19597 \pm 101}$, and the new elements are:—

$$\begin{aligned} u &= 309^{\circ} 10. \\ J &= 118^{\circ} 16 - 0^{\circ} 159 (t - 1898). \\ N &= 187^{\circ} 22 + 0^{\circ} 164 (t - 1898). \\ Q &= 134^{\circ} 91 \pm 12^{\circ} 44. \\ e &= 0.004652 \pm 0.001011. \\ a &= 16''.224. \end{aligned}$$

Prof. Hall remarks that Marth first called attention to the interesting motion of the orbit plane of this satellite, which became evident after the publication of the orbit in 1883. Tisserand and Newcomb pointed out that this motion is probably caused by an equatorial bulging of the planet. The observations indicate motion uniform with the time. This motion is slow, and at the present time assumptions have to be made as to the physical constitution of the planet, and as to the centrifugal force on the planet, so that only wide and uncertain limits can be found for the flattening and for the time of its axial rotation.

Observations of position of the satellite would be valuable, but they must be a complete series, not isolated measures.

GÖTTINGEN 'ANNALS'.—The fifth part of the 'Annals' of this Observatory, which is under the direction of Dr. W. Schur, have come to hand. During the partial eclipses of the Sun on 1890, June 16, and 1891, June 6, a number of measures were made at this observatory to determine the relative places of the Sun and Moon by the observers Dr. Schur, Dr. Ambronn, and Dr. Hayn. The instruments used were the 6-inch heliometer by Repsold (1888), and the 3-inch Fraunhofer heliometer (1814). These observations are here reduced.

AUGUST METEORS.—Fully 65 per cent. of the meteors observed at Greenwich during the recent August display were Perseids. They were principally observed on the nights of August 10 and 11.

THE BEN NEVIS OBSERVATORIES.—It is announced that these meteorological observatories are not to be allowed to close their career just at present. Mr. J. Mackay Bernard, of Kippenross, has generously promised a sum of £500 in order that the observatories may be carried on at least for another year. The question of the existence of these institutions was again brought to the notice of Parliament on August 5, and the Financial Secretary to the Treasury has undertaken to ascertain whether a larger sum out of the parliamentary vote could not be devoted to the high-level observatory.

A CONGRESS of the *Astronomische Gesellschaft* will open at Budapest, Hungary, on September 24. Some of the subjects to be discussed are: questions relating to the international zone-catalogue which is being made under the auspices of the Society; the resolutions of the Paris Conference of 1896; and a report on the revision of the *Piazzi Catalogue of Stars* which is being made by Prof. Porro, of Turin, and Dr. H. S. Davis, of Columbia College, New York.

WE regret to have to record the omission in the list of large refractors published in our June number of a rather important instrument. At the City Observatory, Calton Hill, Edinburgh, there is a refractor of nearly 22 inches aperture and 30 feet focal length. This observatory will probably be formally opened during the coming autumn, when we hope to give a full description of the instruments and building.

WE call attention to the Occultation of Mars by the Moon on September 9, which will happen at Greenwich at half-past one in the afternoon. The circumstances are given in the 'Companion.'

It is announced that Prof. J. R. Eastman has retired from the staff of the United States Naval Observatory. Prof. Eastman has been continuously connected with this institution since 1862.

PROF. J. M. SCHAEBERLE, recently of the Lick Observatory, is on a tour in Europe. We were pleased to see him at Greenwich.

WE should like to bring to the notice of those who read German easily an excellent series of cheap books entitled '*Ostwald's Klassiker der exakten Wissenschaften*.' These are handy little books, about $7\frac{1}{2}$ inches by 5, and on the average contain about 150 pages. We can especially recommend Kant's '*Theory of the Universe*' and Newton's '*Optics*,' copies of which we have recently received. The books are not expensive, as will be seen from the following prices:—Kant's '*Theorie des Himmels*' (1755), No. 12, 2.40 marks; Huyghens's '*Ueber die Licht*' (1678), No. 20, 2.40 marks; Sir Isaac Newton's '*Optik*' (1704), No. 96, 2.40 marks.

WITH reference to the notice of the late Mr. Henry Perigal in our July number, Mr. Woodd Smith writes as follows:—"It may be interesting to note that though, as you say, he attended the Friday evening lectures of the Royal Institution with great regularity, it was only as a visitor until 1895, when he celebrated his *ninety-fourth birthday* (April 1, 1895) by becoming a Member. One might probably search in vain the records of any other Society for mention of a Candidate in his tenth decade."

THE American Academy of Arts has awarded the Rumford Medal to Prof. J. E. Keeler for his application of the spectroscope to astronomical problems, and especially for his investigations of

the proper motions of the nebulae and the physical constitution of the rings of the planet Saturn by the use of that instrument.

The last award of the medal was to T. A. Edison in 1895. Among others who have received this recently are Pickering, Michelson, Langley, and Rowland.

WE have received from Mr. W. T. Lynn a copy of a new work of which he is the author, called 'Astronomy for the Young.' This is a small book of 62 pages, the price is sixpence, and its scope may be gathered from the title. The name of the author is sufficient guarantee of its accuracy and explicitness.

It is announced that Prof. Simon Newcomb will resume superintendence of the astronomical and mathematical work in the Johns Hopkins University. He will especially devote himself to teaching advanced celestial mechanics.

FROM AN OXFORD NOTE-BOOK.

OPPORTUNITIES of meeting other astronomers, though by no means rare, are certainly not too numerous. The whole number of astronomers is small compared with that of devotees to other sciences; there is no commercial stimulus, however indirect; and we are apt to take some time in completing, and more in publishing, our work. Hence opportunities of meeting and talking are specially valuable: as was acknowledged unanimously on the occasion of the Paris Conference in 1887. At the present moment a Conference is being held at Harvard to which we, who cannot be present, will cordially wish every success. "The Conference of astronomers and physicists, held at the dedication of the Yerkes Observatory in the autumn of 1897, was so successful, that the Director, Professor George E. Hale, proposed to hold a second meeting this year, with the expectation of continuing these gatherings in future years." So writes Professor E. C. Pickering, who has, accordingly, undertaken to organize this second Conference. Further, "it is believed that the Conference will have the greatest value and interest if numerous short papers are presented informally, illustrated when desired by lantern-slides, and fully discussed; also if instruments and photographs are exhibited." This seems quite probable.

BIG memoirs are unsuitable for reading at a Conference; they must be printed and read at leisure. But to have the various members comparing notes on minor matters,—methods of work, puzzling discrepancies, attempts and failures—must result in gain to all concerned; and gain none the less real that it may not be tangible. On this side of the Atlantic we have the *Astronomische Gesellschaft*; and the meetings of the Royal Astronomical Society

to some extent supply the need indicated. But it is to be hoped that European astronomers will find time to attend the American Conferences occasionally, if the project of making them annual is successfully carried into effect.

THE notice of the death of Dr. Hermann Romberg in last month's number called up recollections of the delightful visit to Poulkova in 1887, when I made his acquaintance. We did not see the eclipse which we went to see, and this was, at the time, a bitter disappointment; but pleasant impressions have longer lives than unpleasant, and eleven years have nearly effaced the memory of that few days after the eclipse; though I shall never forget the occasion when half a dozen of us met at lunch in Moscow. Hailing from various points of the Central line, we dropped in one by one at the big restaurant with the fish-pond in the middle, where you point out the fish you want cooked for lunch; and as each new long face came in with the old story of thick cloud and disappointment, the countenances of those already assembled grew shorter and brighter; until at last there came one who had seen the total phase moderately well, and beamed on us as he announced his good luck; and this plunged us once more into the gloom of a totally cloudy eclipse.

WE had all met previously at Poulkova, at the table of the veteran Otto Struve, who had talked English, and German, and French, and Italian, and Russian (Spanish also? I forget) to us as nearly simultaneously as the laws of sound permitted; and he had then scattered us along the Central line with a masterly perception of the needs and conveniences of each. He did his very best for us all; and I honestly believe, and believed at the time, that the cloudy weather was not his fault. At any rate the weather was kept in thoroughly good order at Poulkova, for we dined in the open air every day (it was in August) at some odd hour in the afternoon. The astronomical colony at Poulkova, being freed from a cramping civilization, had hours for meals and sleep which best suited observational work. Thus the observers never thought of going to bed before 3 A.M. and yet were ready about 9 A.M. to work up their observations, making up the tale of sleep in the afternoon.

ONE of the most hard working of these observers was Dr. Romberg, who seemed to do the work of several men single-handed. I don't think I am wrong in mentioning 12,000 meridian observations as the number which he had made *and reduced* in one year. On at least one occasion I had a chat with him over long German pipes in his den, and he showed me his collection of photographs of Astronomers, among which, one of Adams with an autograph had a place of honour. I fear I cannot remember what we talked about—probably the difficulties of grappling with German words and tobacco distracted my attention; but I had the privilege of

contemplating an earnest devotion to hard work which made a lasting impression. Did Dr. Romberg join in the evening game of bowls? I rather think his days of bowling were past; he left it to the younger men. The ladies played croquet, which seemed in 1887 an antiquated game, though to-day one might get into trouble by letting slip such a remark. Prof. C. A. Young, one of the visitors destined not to see the eclipse, was a great hand at croquet; he was only in difficulties once, and that was when Dr. Hermann Struve left his bowls and joined the croquet party as a courtesy to us. He seemed to travel round the hoops automatically, and the woeful and remonstrant "Aber Hermann!" with which one of the ladies acknowledged the havoc he had wrought, lives in my ears to this day.

THE date of that eclipse was August 19. This morning came a German paper of the anniversary date (the 'Deutsche Warte' for 1898, August 19), with a note by Dr. George Waltemath marked in blue pencil. The note is about the "second and the third Moons of the Earth," and is to the effect that although these Moons were not seen to transit on the dates announced by Dr. Waltemath, either at Göttingen or Hamburg, they may exist "for a' that." Instances are quoted of specks being seen to cross the Sun near sunset; and 1899, January 24, is announced as a likely date for the next transit of Moon No. II. Lunatics like Dr. Waltemath might be tolerated as comparatively harmless were it not that one has to answer so many times the genial enquiry, "Oh! by the way, how about these new Moons?" and even to write letters about them. The time may come when people with new theories will have to be made to deposit a substantial sum, to be forfeited in case the bubble bursts; and those who want to have questions answered must pay a consultation fee of two guineas. It would probably make them value the replies a little more; and one could buy some nice piece of apparatus with the money obtained. But I fear this will not be arranged before the next century.

TALKING of German newspapers, I had sent to me the other day three numbers of the 'Bierzeitung des Akad. Vereins für Astronomie und Physik,' which seems to be a festive publication produced annually about Christmas, or, as it is technically described on the titlepage for 1895, "Zur Feier des Minimums der Sonnen-deklination"; and in order that the date may be yet more explicit the formulæ

$$\frac{d\delta\odot}{dt} = 0, \quad \frac{d^2\delta\odot}{dt^2} > 0,$$

are inscribed on parts of the artistic device which graces the front page. There is apparently a new Editor each year; but the traditions of the paper are admirably preserved so far as my limited acquaintance with the language allows me to judge. A

general idea of the contributions and the personality of the contributors may be gathered from one or two verses of a poem of which I venture to give the following crude translation, or rather paraphrase:—

And when the crowd melts all away, and comes the early morning,
 'Tis then the few select who stay, a table round adorning;
 For Time and Space as naught shall be
 To Knights of Sociability.

And as from barrel leaps the bung, from heart leaps out the stopper,
 And all that lay within is sung or told in merry "whopper";
 They've sworn that Speech with them is Free,
 The Knights of Sociability.

From these lines it will be understood that the "Astronomische Nachrichten" in the paper is not quite serious. We read, for instance, of a certain Prof. Dr. H. communicating to the *Akad. der Wissench.* the result of his exhaustive analysis of 164 years' meteorological observations as follows:—

1. A warm winter is most generally followed by a warmer or colder summer.
2. A cold winter is most generally followed by a colder or warmer summer.
3. An extremely cold or extremely warm winter is rarely followed by a still colder or still warmer summer.

Again, there is a piece of comet news purporting to come from the "Quarksternwarte U.S.A.," which I hope will not offend our Transatlantic cousins. They have just won a great victory, and so should be able to stand a little chaff:—

With our huge Arizona-Kicker (does this mean an opera-glass?—Ed.) we have naturally been able to make a most accurate observation. We found that the comet generally had no nucleus, but had, on the other hand, two tails separated by only a few minutes of beer (? Bier-minuten). One was of a reddish colour, while the other was greenish. The brightness was about the same as that of the electric arc lamps of the Chicago saloons about ten miles away, as seen in our giant telescope (actually the largest in the world.—Ed.). A better determination of the coordinates was unfortunately impossible, owing to the declination circle having got bent.

Here is a more or less true word spoken in jest:—

Die Grösse eines Astronomen ist nicht proportional der Länge des Fernrohres, sondern eine Orts-Constante;

and an advertisement:—

Ein Lehrstuhl für theor. Astronomie gesucht.

The chaff is distributed all round with pretty fair impartiality and there are many beautiful pictures, including one of a celebrated astronomer riding on a comet, and diagrams, such as those of "beer-curves" and "tobacco-spectra." It is pleasant to know that the study of astronomy is not incompatible with occasional high spirits; and I feel quite grateful to those who sent these numbers "dem Verfasser des Oxford Note-book mit freundlichen Gruss." Any more that they send will be much appreciated.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

OCTOBER, 1898.

No. 271.

Some Reminiscences.—No. III.

WHEN a man begins to indulge in the habit of writing reminiscences he must perforce say something about himself. There is consequently a fear that in speaking of his own doings, in dwelling on the acts and experiences of his own little world, he may exaggerate the importance of the part he has played therein. One of our kings is said to have claimed that he fought the battle of Waterloo. If, in these papers, any similar spirit has appeared, it can only be because I have forgotten a lesson learnt early in life that showed me how little one is really important, and how well the world can do without one. But enough of moral reflection—not a very profitable employment. Let us endeavour to get to something more practical.

Some few further notes on the changes in instrumental equipment at Greenwich in the early part of my time may not be uninteresting. The construction of the astronomical instruments in use at the Observatory when I first knew it differed considerably from that in later years employed. The 10-foot Troughton transit, in use for so many years from 1816, the early part of Pond's time, until the end of the year 1850, did excellent work, but although a good instrument of its class it was of lighter construction than would now be considered satisfactory in a modern public observatory, and the pivots were of small diameter. The instrument had no counterpoises, so that its whole weight rested upon the steel pivots without producing apparently any injurious effect, as was shown by the examinations periodically made. In designing his first new instrument, the altitude and azimuth instrument, afterwards called for brevity the altazimuth, and less respectfully within the observatory walls "the altaz," an instrument brought into use in 1847 for making observations of the Moon earlier and later in each lunation than was possible with the meridian instruments, Sir George Airy adopted a construction of more massive character, including as many parts as possible in one casting, avoiding the

union of parts by small screws, and diminishing the power of making adjustment. The essential portions of the instrument were contained in six castings, the microscope carriers being cast in one with the framework. I had been in the habit of observing with the meridian instruments then in use, and became impressed with the solidity of the parts of the new instrument on their being brought to the Observatory. The first observation of the Moon was made on May 16, 1847. In the reduction of the observations the Astronomer Royal adopted the plan of referring the Moon's place, not to the centre of the Earth, but to the point at which the normal at Greenwich meets the Earth's axis, and he remarks "I am not aware that this method has ever been suggested before" (Rep. to Board of Visitors, 1846, p. 6). The printed skeleton-forms of reduction having been previously prepared, when the reduction of the observations for the first lunation were approaching completion, being myself employed upon the work I felt much curiosity in coming to the final figures to see whether the resulting errors of the Moon's tabular place would turn out to be consistent. Expectation was fulfilled, and by means of this instrument valuable observations of the Moon near to conjunction with the Sun have been since obtained. During the erection of the altazimuth building an unfortunate accident occurred—a foreman of works fell into the foundation-pit and broke his leg, of which misfortune he died.

The altazimuth was followed a few years afterwards by the erection of a new transit-circle, which, replacing the Troughton transit and mural-circle, was brought into use at the beginning of the year 1851, and is still employed. Solidity and firmness of construction were again essential features, the new instrument, as in the case of the altazimuth, being made in as few separate parts as possible, and without means of adjustment in level or azimuth. During the 34 years ending 1884 (see paper by Professor Turner at p. 325 of vol. 47 of the R. Ast. Soc. Notices), on three occasions only has it been found necessary to alter the meridional position of the instrument, the first being in the year 1870, after 19 years of work, on account of a progressive change having caused the error of level to become inconveniently large (drop of the eastern pivot relatively to the western one, to which I have referred in a previous paper). The annual values (west end high) increased from $-3''\cdot39$ in 1851 to $+2''\cdot26$ in 1857, $+6''\cdot85$ in 1863, and $+10''\cdot02$ in 1869. On correction of this error the progression in the immediately following years was in the opposite direction. The azimuthal error (east pivot north) shows also progressive change, mostly increase of value, but not, at different times, at the same rate. It may be remarked that the term "error" (of level or azimuth) is perhaps hardly a proper one, since for stars south of the zenith, on which side most of the observations are made, multiplication by the proper factor gives the "correction" to the observation. Unlike Troughton's mural circle (previously in use)

the clamping-screw of the transit-circle was made without any slow-motion arrangement, so that after clamping the circle the bisection of a star by the horizontal wire can only be made by use of the telescope micrometer. In the mural circle the bisection could be made by the slow-motion screw, but this was a less delicate method of observation. The mural circle at first carried two horizontal wires, one fixed and one moved by a micrometer-screw. Thus a star could be bisected either with the fixed wire by use of the slow-motion screw, or with the movable wire by use of the micrometer. In the year 1843 the fixed horizontal wire was removed, after which, when bisection was not made by use of the micrometer, it was done as before by the slow motion of the clamp, using the micrometer-wire set always to one definite micrometer-reading. In the construction of the newer instruments another circumstance is to be noted, the circles of former instruments being independently divided, were liable to accidental errors of division; but the new instruments being graduated on a dividing-engine, a greater uniformity in the law of error was obtained. In the Reports to the Board of Visitors for 1848 and 1851 instances are given of inconvenience caused by irregularity of division in the mural circle, although this was understood to be a favourite specimen of Troughton's work. Unlike the mural circle, in the new transit-circle the microscopes for reading the divided limb were all illuminated by one central light. In another respect there was difference. The mural circle appears to have been originally constructed, when set up in 1812, so as to allow the telescope to be moved to different parts of the limb, and this was done for several years; in 1821 the telescope was fixed in a more permanent way, and apparently was not again moved until 1836, after which the custom of shifting the telescope on the limb was again followed, a shift of a considerable number of degrees, not always the same in amount, being made at the beginning of each successive year, but in the transit-circle the telescope is a fixture as regards the circle. Each method may have advantages. Whilst periodical shift of the telescope may tend to the correction of instrumental errors of accidental character, the fixed telescope has the advantage that, in the determination of astronomical constants, such as aberration or nutation, from the observation of some particular star, the measures are referred to the same portion of the divided circle.

The erection of the transit-circle was followed after some years by that of the south-east equatorial, carrying an object-glass of $12\frac{1}{2}$ inches aperture. In the construction of this instrument, brought into use in the year 1860, Sir George Airy adopted what is known as the English method of mounting, and with this third instrument he completed his re-organization of the principal astronomical instruments of the Observatory. A few years ago, however, the $12\frac{1}{2}$ -inch glass was removed by the present Astronomer Royal, Mr. Christie, who substituted for it, on the same mounting, a

28-inch object-glass, replacing the former revolving dome by a new one adapted to the larger telescope. He has also added other large telescopes, one of 13 inches for the astrographic work, and another of 26 inches (presented by Sir H. Thompson) employed on photographic work. Further, the observations of the Moon made with the old altazimuth erected in 1847 were discontinued in 1897, after the instrument had reached its jubilee of work, a new and larger altazimuth having been erected in another part of the Observatory grounds. But of these recent important additions to the instrumental equipment of the Observatory it is not my object further here to speak, indeed I am not sufficiently acquainted with the details of construction to say more than that great solidity in this respect continues to be a main feature.

Turning now from the activity which the mere mention of the instruments just enumerated suggests, let us survey a little the progress of things in general from earlier times. Formerly the work of an observatory was of a less extensive character, the sometimes monotonous meridian routine being occasionally relieved by the observation of an eclipse of one of Jupiter's satellites, or of an occultation of a star by the Moon, or perhaps, by way of a treat, a little double-star work might be indulged in, or haply a comet might come along, otherwise a comparative quiet prevailed. But this innocent and happy primeval state became eventually broken in upon, on the gradual development, by an ever-increasing photographic and spectroscopic army, of what is now called the new astronomy, which not only disturbed our previous notions, but hampered us also with messing chemicals, galvanic batteries, and other complicated apparatus mostly chronically affected with a faculty of getting out of order. Our neat observing-rooms were converted into objectionable and unlovely laboratories, and astronomers became also chemists and photographers, electricians and mechanics, in order to map and measure the whole visible creation, and indeed some portions of the invisible. No doubt it was all very proper, but these new-fangled notions were a little irritating to the older folk. Nelson is said to have been dissatisfied with one of his chiefs for thinking, after a naval battle, that they had done very well in the number of prizes taken, when more might have been secured. But there are also astronomical Nelsons, equally difficult to satisfy. Formerly, when it was wished to find the longitude of a distant point, if we could by lunar or other methods obtain results differing one from another by a handful of seconds of time, we felt a certain degree of jubilation; but now, with the electric telegraph, if two independent measurements of some position on the other side of the world differ only by, say, $0^{\circ}25'$, the proper thing seems to be to make a new determination. If this sort of thing goes on we shall, in the twentieth century, be fighting about $0^{\circ}01'$. Then, again, inordinate curiosity in another direction has only led to the discovery of the perplexing variation of latitude. Having got it, what are we going to do with it?

Include it in our reductions? To think that we should come to variable terrestrial as well as variable celestial co-ordinates!

It must, however, be said that if former times were less exciting, they had occasionally also their surprises. In those days it had been concluded that the solar system consisted of Sun, Moon, the five old planets, with Uranus and four minor planets, and one or two comets, with a remote possibility, according to some advanced minds (such did exist even in those days), of a planet beyond Uranus. We had, however, been left in peace since 1807, and were in no way anxious that the solar system should be further tampered with. A satellite to Mars! Preposterous! Possibly two, somebody says. Absurd! Why that is more than we have ourselves, and we are much bigger than he is. Some increase, then, in the number of minor planets? Not necessary: are not four enough? Imagine, then, the excitement felt by astronomers when it became known that on one fine evening in December 1845 a too-inquisitive German had found a new minor planet. This was *Astræa*. I remember the surprise of astronomers at this unexpected discovery. Actually another planet! Not content, however, with what he had done, the same reckless individual must needs find another, *Hebe*, in 1847. But it would not do that our continental neighbours should have all this to themselves, so our own Mr. Hind produced *Iris* and *Flora* in quick succession, after which others joined in the search, increasing the number of these bodies to such an extent that, after a time, the discovery of a new one did not make one's pulse beat the one-thousandth part of a second faster. There are more than 400 of these bodies now known, and since they can, with little trouble, be picked up from photographic plates, curiosity has languished. Probably some other system, deficient in this respect, would like to receive a consignment of these bodies from us. We might make a tempting offer, especially if a number were taken.

Hardly, however, had we resigned ourselves on the discovery of *Astræa* to the possibility of some reform of the solar system in this direction than a wonderful thing occurred, the staggering fact of the existence of a large planet beyond Uranus becoming revealed to us by the discovery of the planet Neptune in the year 1846.

Here was change in the solar system—minor planets added within, and a big planet without! But there remained yet another surprise for us. Before many years had elapsed the sporadic meteors, looked upon as mere intruders, not to be behindhand, seeing how things were going, became emboldened to put forward a plea of kinship with the solar system, affirming their allegiance to the Sun, and claiming to move in orbits as regular as those of the planets. Why should they not be recognized? Here was a climb-down for us. To admit so many minor planets was lowering enough, but to allow similar honours to these chits of bodies——! The request appeared to be a little presumptuous, but on second thoughts, remembering how the meteors by the self-immolation of

many of their members, have made things brilliant for us in the celestial sphere, providing us with exhibitions such as that of 1866, and promising that this shall be repeated in every generation, it seemed only proper that their petition should receive consideration, and so those families of meteors that had really proved their attachment to us became acknowledged members of our system. The poor Sun! With such a tribe to control, he has enough to do.

Having made, I trust, an interesting contribution to the "history of our own (astronomical) times," I will conclude my paper with an episode of more personal character. Before the number of minor planets became so numerous, the observation of these bodies formed a pleasant diversion from other astronomical work. When I left Greenwich in 1852 to take charge of the Durham Observatory (succeeding Mr. Carrington, who had just previously made a chronometric determination of the longitude of the Durham meridian), the number of minor planets known was 15; before my return to Greenwich in 1853 they numbered 26. The work carried on during my year of office consisted mainly of equatorial observations of minor planets and of comets, following up especially the newly-discovered planets, a line of work which I pursued with some degree of vigour, making and publishing in the '*Astronomische Nachrichten*' a fairly good series of observations. As the time of opposition of the planet Hygeia in 1852 approached, no ephemeris was to be found. I remember computing one, and finding the planet on the first following clear night. In the equatorial work I endeavoured always to compare the objects under observation with stars whose places were known with fair accuracy. Others discovered that the planet-places were trustworthy, and Mr. Hind (then at Bishop's Observatory in the Regent's Park) was glad to get my latest observations of the newer bodies, of which he had discovered four between June and December 1852. The first of these four possesses a mournful interest, discovered by Mr. Hind on June 24, he requested Sir George Airy to give the planet a name. It happened that there died on the same day his "most dear, amiable, clever daughter Elizabeth," and of two suggested names that of Melpomene was adopted. It was at Durham that I had to learn to observe and write in the dark, some of the minor planets—Irene especially in my year—being so faint that no exposed light could be tolerated in the observing-room. Very conveniently the sidereal clock stood in an adjoining room, its face being readily seen through an opening in the wall.

It was in the early part of the year 1853, whilst at Durham, that I first saw the zodiacal light. Going out one evening soon after sunset to view the sky, an appearance in the west at once attracted my attention, the form of which immediately told me that I was confronted with the zodiacal light. It was visible also on other successive evenings and was quite bright. The observatory, being situated on a hill away from the town, was well placed for an observation of the kind. There being in those days no

telegraphic distribution of time from Greenwich (though such a system was in operation before the following year), I used to give Greenwich time, determined from Durham transits, to the principal watchmaker of the town. I enjoyed very much my year at Durham, and left the work with regret, hesitating for a time to return to Greenwich, but other circumstances had to be considered. During my after-life at Greenwich I have, however, been brought into connection with a great variety of interesting work, some particulars concerning which I have, from time to time, endeavoured to incorporate in these papers. W. ELLIS.

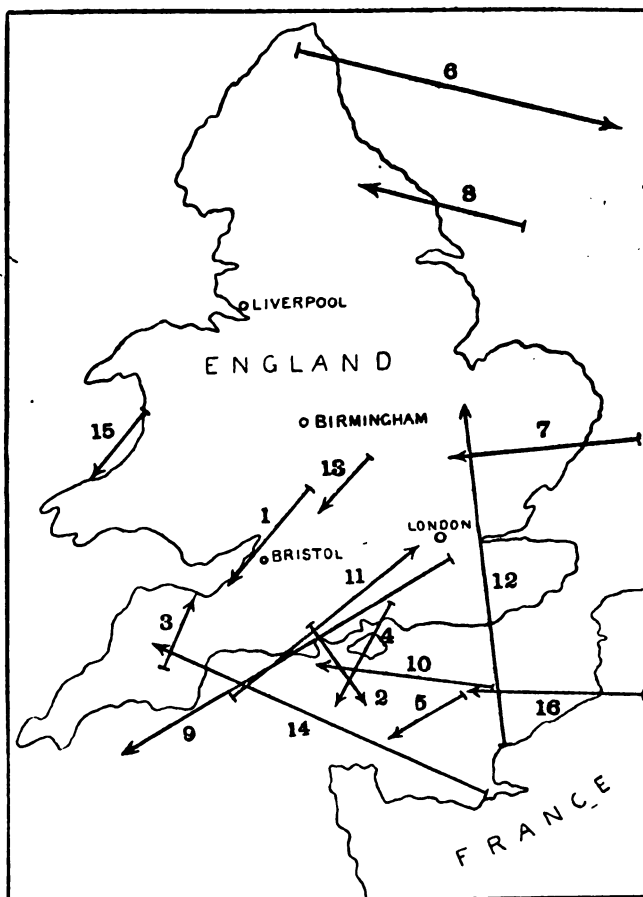
Large Meteors observed in 1897 and 1898.

A LARGE number of fireballs and tolerably bright meteors have been observed in England during the last 18 months, and a proportion of these objects were recorded with sufficient accuracy and completeness to enable their real paths to be determined. In a few cases the observations present some inconsistencies, but an endeavour has been made to derive a satisfactory result from them. The radiant-points found from these materials are, in most cases, very interesting as affording evidence of new showers or corroborating those previously observed.

The results are appended in a tabular form. It is clear, from the number of brilliant meteors which have been seen and described by various observers in recent years, that this department is receiving more attention than formerly. It is hoped that this interest will continue to increase, and that the fortunate spectators of fireballs will never forget to record those all-important features viz., the direction and position of the flight amongst the stars and the duration of visibility.

Notes.

1. Radiant-point near α Draconis probably very exact. Mr. Grover, at Lyme Regis, estimated the brightness of the meteor as $\frac{1}{2} = 2$.
2. The observations were somewhat discordant, and the resulting path only approximate.
3. Excellently seen by two practised observers. The nucleus broke out into flashes and left a beautiful green knotted streak for 5 or 6 seconds.
4. Height unusually great. Possibly two brilliant Perseids appeared at nearly same time. The projected radiant is at δ Persei and 12° S.E. of the Perseid centre on Aug. 8.
5. In this case also the abnormal height induces a suspicion that the objects observed may not have been identical. The radiant is 12° S. of the usual Perseid position; but quite possibly this, as well as the last meteor, may have belonged to the α - β Perseids, which sometimes form a rich companion shower to the major display.
6. This fine long-pathed meteor was insufficiently observed, and the resulting radiant cannot be regarded as accurate.
7. A fine Geminid, fairly well observed.
8. Though occurring at the Geminid epoch this was one of the ζ Taurids. Its real path was satisfactorily defined from several good observations.



9. A very brilliant long-pathed meteor which was numerous observed in the evening twilight. The nucleus had a diameter of 12" or 15", but seemed to be brighter than the Moon.
10. Another fully observed meteor. It left a thick train of sparks.
11. The observations were made by experienced amateurs, and the resulting path is probably very reliable. The object moved with extreme slowness from a previously unknown westerly radiant.
12. The meteor appears to have detonated when passing over the borders of Hertford and Essex. Its path was from N. to S., but the descriptions are not quite so definite as could be wished.
3. An early and tolerably bright Perseid. The radiant derived from the pair of recorded paths is about 4° W. of the normal position of the Perseid centre for the date.
14. Well observed in the evening twilight. The meteor was evidently a late member of the rich Aquarid shower usually seen at the end of July and

Real Paths of 16 large Meteors observed in England during the Years 1897 and 1898.

No.	Date.	G.M.T.	Mag.	Height and place of appearance.	Height and place of disappearance.	Length of obs. Path.	Velocity per second.	Earth-point.	Radiant-point.	Observers.
1.	1897. April 30.	h m 9 38	5 × ♀	miles 59 Cheltenham.	miles 18 Banwell, Som.	miles 70	miles 23	Taunton.	291 + 59	W. F. D., C. Grover, & 5 others.
2.	July 30	8 47	> ♀	54 Poole, Dorset.	23 Engl. Channel.	50	13	Engl. Chan.	155 + 59	5 obs.
3.	Aug. 2	13 57½	3 × ♀	81 10 miles E. Tavi- stock, Devon.	47 Watchet, Som.	59	36	10 miles S. E. of Hereford.	312 ± 0	A. S. H. & H. Corder.
4.	Aug. 8	9 15	> ♀	133 Chalfield, Hampshire.	115 Engl. Channel.	63	42	.....	52 + 47	A. S. H. & N. Latley.
5.	Aug. 9	14 18	3 × ♀	137 Engl. Channel.	75 Engl. Channel.	75	Swift.	Alderney.	44 + 45	A. S. H. & W. E. Besley.
6.	Oct. 22	6 23	> ♀	59 Wooler, North- umberland.	35 North Sea.	171	V. slow.	North Sea.	218 + 10	5 obs.
7.	Dec. 9	9 47	½ = ♀	76 Aldeburg.	21 Roydon.	90	Swift.	Amphill, Beds.	113 + 32	3 obs.
8.	Dec. 12 1898.	8 6	½ = ♀	112 North Sea.	19 Thirsk, Yorks.	151	25	Richmond, Yorks.	80 + 23	Many obs.
9.	Jan. 21	5 32	½ = ♀	82 Oroydon, Sur- rey.	25 Engl. Channel.	235	34	Engl. Chan.	130 + 30	33 obs.
10.	Feb. 20	8 54½	> ♀	61 Engl. Channel.	27 Engl. Channel.	95	24	Teignmouth, Devon.	176 + 12	18 obs.
11.	April 5	10 15	2 × ♀	89 Engl. Channel.	25 Bisley.	162	11	Braintree, Essex.	121 - 1	5 obs.
12.	July 26	9 10	¾ = ♀	73 Coast of France.	27 March, Cambs.	191	Slow.	Bridlington, Yorks.	269 - 23	5 obs.
13.	July 30	10 43	4	81 Northampton.	47 Buryford.	57	36	Cheddar.	23 + 53	A. S. H. & W. F. D.
14.	Aug. 11	8 58	> ♀	66 Mouth of the Seine.	41 Okehampton.	196	22	S. of Ireland.	339 - 10	15 obs.
15.	Aug. 11	10 15½	4	92 Aberdarey.	68 Cardigan.	45	Swift.	St. George's Channel.	44 + 56	4 obs.
16.	Aug. 21	9 16	> ♀	60 Cressy, France.	29 Engl. Channel.	95	19	Engl. Chan.	5 + 13	7 obs.

beginning of August, and its long, nearly horizontal flight was noticed by many people in the S. of England.

15. A fine Perseid, variously estimated from 1st mag. to $= \varphi$, and its path accurately recorded by four observers who were watching for meteors at the time of its appearance.
16. A very bright Pegasid, well seen at Slough and Worthing.

Bristol, 1898, Sept. 13.

W. F. DENNING.

P.S. Sept. 24.—Several fine meteors have been observed in September. On the 15th, at 8^h 17^m, a bright long-pathed meteor was seen at Slough by Col. J. Herschel, and at Bristol by the writer. It was one of the September Perseids, its radiant being at $65^{\circ} + 35^{\circ}$. The meteor passed from over a point near Thame, Oxon, to Salisbury, at heights from 69 to 61 miles, and its length of path was 58 miles, velocity about 39 miles per second. On Sept. 18, 8^h 54^m, a meteor brighter than Jupiter was seen by the Rev. T. E. R. Phillips at Yeovil, and by several observers at Bristol. The radiant was probably near β Aurigæ, at $84^{\circ} + 41^{\circ}$, and the position of the object was from 69 miles over Minehead to 46 miles over the English Channel about 20 miles S.E. of Falmouth. Its observed course extended over 104 miles.—W. F. D.

The New Planet DQ.

THE discovery of a new minor planet is hailed as a rule with equanimity, not to say indifference. The number has grown so large, and they are for the most part of so little practical importance in astronomy, that but few observers care to devote themselves to the search for them. But the planet DQ, discovered by Herr Witt, of the Urania Observatory, Berlin, on Aug. 13 last, aroused from the first exceptional attention, since it was retrograding at the unusual rate of 2^m daily in R.A., from which fact its orbit was evidently one of singular interest. A large number of observations was accordingly obtained, and Dr. Berberich publishes, in *Ast. Nach.* 3517, his first determination of the elements of the orbit, based on three observations by the discoverer made on Aug. 14, 23, 31. The orbit is of a very sensational character, and quite revolutionizes some of our ideas of the Solar System. We have always looked on Mars as our nearest outside neighbour; it was, indeed, known that one or two of the group of minor planets were slightly nearer to the Sun when at perihelion than Mars is when at aphelion. But the mean distances of the latter were in all cases much greater than that of Mars, while that found for the new planet is only 1.46 as compared with 1.52 for Mars; and, as the eccentricity amounts to 0.23, the perihelion distance is only 1.13, and the least distance from the Earth's orbit only 0.15, as compared with 0.27 for Venus in transit, and 0.38 for Mars in

Perihelion. The planet will thus be at times far closer to us than any other member of the solar system, and will afford a most excellent means of determining the Sun's parallax, the parallax of the planet when nearest being more than $1''$. We may thus hope to determine the Sun's parallax with an accuracy three times as great as that given by any previous method.

The following are Dr. Berberich's elements:—

Epoch.....	1898 Aug. 31.5	Berlin M.T.
M	220° 14' 3".7	
π	122 17 14.2	} 1898.0
$\varnothing$	303 48 53.0	
i	11 6 57.1	
ϕ	13 13 3.8	
μ	2010".131	
log a	0.164521	
Period.....	644.734 days	
Perihelion distance 1.1266, aphelion distance 1.795.		

In order to get an idea of the amount of confidence that could be placed in these elements, Dr. Berberich compared the computed and observed places for 43 observations made during August. The following table is based on his, but the observations have been combined in groups, and one or two obviously erroneous ones have been excluded:—

Day.	Observed R. A. —Computed.	Observed Decl. —Computed.	No. of Observations.
	s		
1898 Aug. 14	—0.04	+4.4	7
Aug. 17	+0.05	+6.5	9
Aug. 19	+0.03	+7.0	10
Aug. 21	0.00	+7.0	9
Aug. 23	—0.11	+7.7	4
Aug. 28	+0.08	+4.6	2
Sept. 7	+1.46	—3.8	3
Sept. 10	+2.58	—4.2	4

The agreement during August is certainly as close as could reasonably be expected. Dr. Berberich explains that the constant error in declination is due to the distance of the planet having been assumed too great, and consequently the parallax applied being too small; but the effect of this error on the elements will not be serious.

It is of course desirable to obtain observations extending over as large an arc as possible, and Dr. Berberich contributes an accurate ephemeris up to Oct. 4, of which a portion is given here extended approximately to Oct. 16. The planet will still be of the 12th magnitude at the beginning of October, and may therefore be followed for some considerable time.

Ephemeris for Berlin midnight.

	R.A.			S. Dec.			R.A.			S. Dec.	
	h	m	s	°	'		h	m	s	°	'
Sept. 30..	20	35	23	6	16	Oct. 12 ..	20	39	12	6	0
Oct. 4..	20	35	57	6	12	16 ..	20	41	49	5	51
8..	20	37	14	6	7						

Although the elements given above are avowedly only a first approximation, yet from the very interesting relations which this orbit presents I have made some investigations on the assumption that they are strictly accurate.

First as to the frequency of opposition; the mean synodic period is found to be 2.30692 years, and the multiples of this period are given in the following table:—

Synodic Periods.	Years.	Synodic Periods.	Years.
1	2.31	8	18.46
2	4.61	9	20.76
3	6.92	10	23.07
4	9.23	11	25.38
5	11.53	12	27.68
6	13.84	13	29.99
7	16.15		

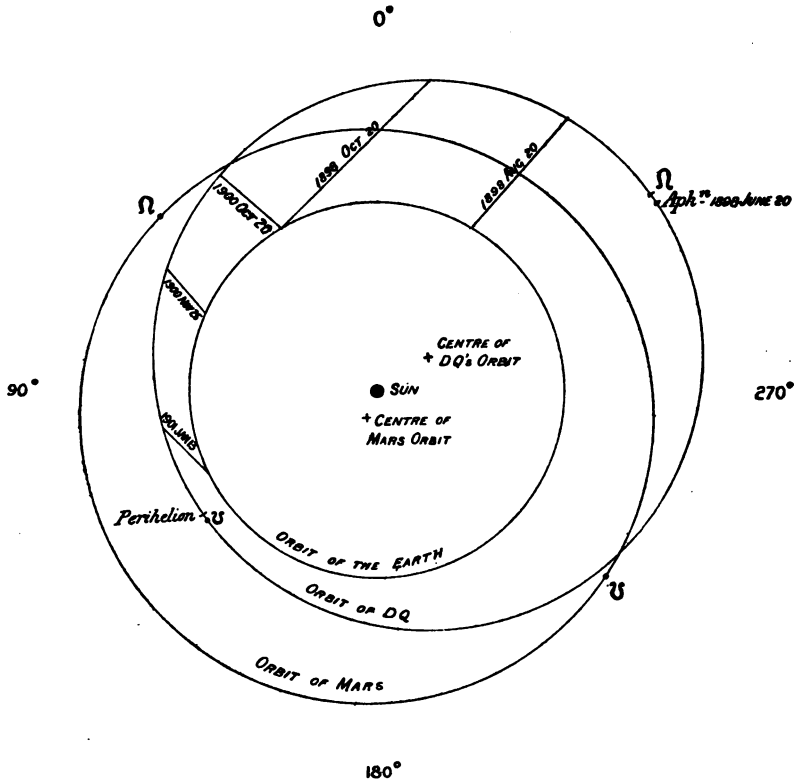
Thus three synodic periods are equal to seven years less one month, and oppositions are repeated after this period in approximately the same regions of the orbit. But a much closer adjustment is effected after 13 synodic periods, 17 revolutions of the planet being almost exactly equal to 30 of the Earth.

The next inquiry that one naturally makes is, when will the planet be in opposition in perihelion? The Earth passes the longitude of the planet's perihelion on Jan. 22, and consequently the planet must pass perihelion on or near that day to secure the closest approach to the Earth. The following table of perihelion passages is deduced from the above elements:—

1894 Jan. 21	1909 Dec. 11
1895 Oct. 28	1911 Sept. 16
1897 Aug. 3	1913 June 21
1899 May 9	1915 March 28
1901 Feb. 12	1917 Jan. 3
1902 Nov. 19	1918 Oct. 9
1904 Aug. 25	1920 July 14
1906 May 31	1922 April 19
1908 March 5	1924 Jan. 25

It is rather tantalizing to find that an opposition under the most favourable circumstances possible took place in January 1894, and it seems very strange that the planet was not detected on that occasion,

as it must have been of about the 7th magnitude. It may still be worth while to examine plates of Cancer or the neighbourhood taken in January 1894, in the hope of discovering a trace of the planet upon them. An equally favourable opposition will not occur till January 1924, and in the meantime we shall have to rest content with the opposition of 1900, which is more favourable than any other till 1917. The planet will be in opposition early in November 1900, but will be at its least distance about a month



later, its distance then being about 0.33, or decidedly less than that of Mars at the most favourable opposition, so that observations for parallax should certainly be secured at the coming opposition. It will then be of the 8th or 9th magnitude, while at the recent opposition, when it was near aphelion, it was only of the 11th.

It is to be noticed how close the line of nodes lies to the major

axis of the orbit; a much closer approach to the Earth's orbit is thus produced than would be the case if they were inclined at a large angle. It is curious that the least distance of the orbit of DQ from that of Mars is about 0.23, nearly twice that from the orbit of the Earth, in spite of the closeness of their mean distances; this arises from the high inclination to one another of the two orbits, and the unfavourable position of the line of nodes.

The apparent motion of the planet as seen from Mars would be very complicated; it would sometimes be in opposition, sometimes in inferior conjunction with the Sun, sometimes among the polar constellations, sometimes gaining on Mars in longitude, at other times being left behind.

As regards the geocentric motion there is one point in which it is absolutely unique among the superior planets. Every other planet when in opposition retrogrades in longitude; but DQ when in perihelion has a velocity whose resolved part in the plane of the ecliptic is 1.0247, while the Earth's velocity at the same longitude is 1.0157; the unit of velocity being that of the Earth at her mean distance from the Sun. Consequently the planet will be *advancing* very slowly in longitude; it will at the same time be moving southward in latitude about $1\frac{1}{3}^{\circ}$ per day, in consequence of its high inclination. The diameter of DQ is probably about 17 miles, if its albedo be about the same as that of Pallas. Its disc would in this case subtend an angle of $\frac{1}{4}''$ at the most favourable oppositions, which would not be measurable in the largest instruments. Its mass would be $\frac{1}{2,000,000}$ of that of the Moon, if the densities be assumed equal; which is an absolutely negligible quantity. But the perturbations of DQ by the Earth will be very considerable, and will in time furnish another accurate determination of the Sun's distance.

It has been suggested that the planet may have recently been introduced into the Solar System through perturbations; but this does not seem possible, as the orbit does not approach that of any large planet sufficiently closely. The least distance from the orbit of Jupiter is 3.2, and the Earth cannot have recently captured it unless the orbit approaches ours much more nearly than the distance indicated by Dr. Berberich. The probability of the capture of a body by the Earth is practically evanescent, and it seems pretty clear that DQ is an original member of the Solar System. Its discovery suggests quite new possibilities as regards regions in the Solar System which have hitherto been regarded as absolutely blank. There may be other such bodies whose orbits lie within that of the Earth; but the search for these would necessarily offer much greater difficulties, and observers are scarcely likely to undertake the labour with such a slender chance of success. Enough has now been said to show the interest and importance of the new discovery. All will await with curiosity the computation of more exact elements, and it is to be hoped that

Those who possess the necessary optical means will continue their observations as long as possible, as the circumstances of the next opposition will thus be ascertained with greater accuracy.

A. C. D. CROMMELIN.

The Great Sun-spot of September 1898.

A SUN-SPOT of the first magnitude only two years before—in the ordinary course of the cycle—minimum is due, is indeed phenomenal. But the Sun, during the course of the present decline, has delighted to spring these little surprises upon its observers. After the maximum at the end of 1893 it proceeded on its course for some time in strict accordance with all the recognized traditions. 1894 was just a little less “spotty” than 1893, but a year of continual disturbance. 1895 showed a marked falling off on the average, but on no single day was the Sun entirely spot-free; the first instances of a completely clear disc occurring in April 1896. During the two and a half years which have followed, the clear days have steadily increased in frequency, and the number of days with hardly any spots has also grown. So far precedent has been strictly followed. But between the times of total or almost total quiescence there have been a number of outbursts which, for vigour and extent, have quite rivalled all but the very greatest of the time of full maximum. The great group of September 1896, the longest ever photographed at Greenwich, the groups of December 1897, and of March and now of September 1898, will occur to every sun-spot observer as examples of these belated efforts.

The present group was first seen at Greenwich on the morning of Saturday, September 3. It must have been visible as a notch on the limb on the preceding afternoon, but had not come into view in the morning, when the usual photographs were taken. As seen on the Saturday, it consisted of a single well-defined spot with dark umbra, in the midst of a succession of long ridges of bright faculæ. Its area was about 1200, as expressed in millionths of the Sun’s visible hemisphere. The next two or three days the group gradually came into fuller presentation, and it was seen that though the spot was fairly regular in general outline, its margin was invaded by numerous bright tongues of photospheric matter, the appearance and behaviour of which proved very interesting. In particular, a great wedge thrust itself deeply into the umbra from the S.W. on September 4, and by September 5 was seen as a double tongue of light, which on reaching the centre of the umbra was bent back at a sharp angle. These bright bridges had become even more complicated by the following day, and the spot had suffered invasion by a broader mass of photospheric matter on the N.W. side, which threatened to sever a considerable part of

the spot from the main body. Up to this time the great spot had remained almost stationary in area, or had indeed slightly diminished. A few small followers were seen on September 5, which had increased to a considerable stream by September 6.

By September 7 the group had assumed its typical form of a long irregular train of spots, the original spot still the leader and still much the largest, and the following spots chiefly collected into two complex clusters. The general aspect remained much the same on September 8 and 9, but the group was increasing in size and lengthening out the meanwhile, and on September 10 had attained its greatest development, its length being then over 18° of solar longitude, its breadth about 5° of solar latitude, and its total area about 2300, of which the great spot contributed 1400. The group on this day consisted of five chief divisions, viz., a small cluster that had been thrown out *n.p.* the chief spot, the chief spot, and three following clusters, the middle of which had formed between the two clusters of September 7 as these latter moved away from each other, through the tendency of the group to spread out in longitude. The group was 5° long on September 3, 12° on September 6, 16° on September 8, and now 18° on September 10.

After this a gradual decline set in. The small spots in the centre of the following stream first faded out, then those immediately preceding and following the great spot. The great spot was last seen—as a notch on the west limb—on September 15, and it was then followed only by one spot, the rearward spot of the preceding day. By September 16 the entire group had passed out of sight.

The group was passing over the central meridian of the Sun the whole of Friday, September 9, the centre of the great spot reaching that point about $0^h 30^m$ Greenwich civil time on the morning of that day. In accordance with the general run of past experience, that auroral displays and magnetic disturbances occur when a great spot has passed the central meridian a few hours, a striking magnetic storm began shortly after 2^h P.M. on September 9, and reached its height between 8^h and 11^h P.M., during which latter time a very fine aurora was in full activity.

The popular interest in the sun-spot has centred round a question which has come very forcibly home to a good many people. Not many people know or care about the vagaries of a declination-needle; the aurora might pass unnoticed or gazed at as a superior kind of firework. But day after day in September, with the thermometer at 90° in the shade*, and heaven knows what in the Sun, and one-third of London put on shipwreck rations of water, constituted a state of things which cannot be ignored, and the question has been loudly and widely asked: "Are this heat-wave and this drought due to the sun-spot?"

The drought certainly is not due to this particular sun-spot,

* See note, p. 387.

since it has been steadily coming upon us for several years past. The heat-wave is probably equally innocent of any connection with it, and one has only to look back to other great spot-displays to see that they are quite as capable of co-existing with cold, or cloudy, or rainy weather, as with an abnormal heat-burst. But the popular enquiry had this justification on the present occasion, that the heat-wave and the spot ran their courses almost exactly at the same time, and attained their greatest development together. No doubt the coincidence will frequently be quoted in the future, in forgetfulness of the old proverb that "One swallow does not make a summer," or, as we may put it, "One coincidence does not prove a law."

E. WALTER MAUNDER.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Comet II. 1861.

GENTLEMEN,—

This magnificent comet was first seen by Mr. Tebbutt on May 13. After assuring himself (*Ast. Nach.* No. 2211, vol. xciii. col. 47), by means of the imperfect instrument at his disposal, that the object in question was really a comet, for it moved extremely slowly for some days, he announced the discovery to the Sydney Observatory and to the 'Sydney Morning Herald.' Scott, then Director of the Sydney Observatory, received the announcement on the 21st, but states ('Monthly Notices,' vol. xxi. p. 254) that he was not able to obtain observations of any value until the 27th and 30th, by which time the comet was just visible to the naked eye after sunset. These observations were made with a ring-micrometer on Sir Thomas Brisbane's old equatorial; but a new Merz equatorial with 7-inch object-glass was mounted on June 4, and a series of observations obtained with it from June 8 to 26. Meanwhile the comet had been seen at Hobart Town on the morning of June 4 (and announced in the 'Mercury' of June 7), and Mr. F. Abbott obtained a series of observations from June 6 to 20, which are printed in the 'Monthly Notices,' vol. xxi. p. 260; but, he remarks, the places are only approximate, because he had a few days before sent his equatorial to Melbourne.

Mr. Tebbutt was not only the first discoverer of the comet, but the first to calculate its orbit. This he did by means of an approximate observation made at the Sydney Observatory on May 24 and sextant observations of his own at Windsor on June 3 and 11.

The perihelion passage, we now know, took place about midnight, Greenwich time, on June 11, and the comet became visible in Europe before the end of that month, observations being

obtained at Paris, Cambridge, and Breslau on June 30. It then presented a magnificent appearance, and Sir J. Herschel, who observed it at Hawkhurst, considered that it far exceeded in brightness any comet he had ever seen, those of 1811 and 1858 not excepted. According to Seeling's ephemeris, its distance from the Earth was then about 0.80 in terms of the Earth's mean distance from the Sun, and it is thought that we passed through a portion of the tail. The brightness afterwards rapidly diminished, and at the end of August it was not much more than a tenth of its maximum. It continued visible, however, until the following spring, the last observation being by Winnecke at Poulkova on 1862, March 22 (Ast. Nach. No. 1357, vol. lvii.* col. 207).

This comet's orbit is remarkable for its great inclination to the plane of the ecliptic, which exceeds 85° . The ellipticity is such that the period certainly exceeds four hundred years. Seeling's calculation (Ast. Nach. No. 1347, vol. lvii. col. 39) made it 419.5 years. But in 1880 Prof. Kreutz made an exhaustive discussion of all the published observations, which forms the subject of an inaugural dissertation for his doctor's degree at Bonn in July of that year, under the title "*Untersuchungen über die Bahn des grossen Cometen von 1861 (1861 II.).*" An abstract of this appears in 'Nature' for 1881, November 24 (vol. xxv. p. 94), and it is mentioned in the Smithsonian Report for that year. The result is that the period of revolution amounts to 409.40 ± 0.37 years, and the plane of the comet's orbit is nearly perpendicular to that of the ecliptic, the inclination amounting to $85^\circ 26'$. Prof. Kreutz reserved for future consideration the question why there is no record of any previous observation of this fine comet, but thinks that when the perihelion passage took place about the middle of the fifteenth century the comet was so situated that it was not likely to have been conspicuous in the northern hemisphere. Our successors in 2270 will probably not fail to see it; but it must be borne in mind that its aphelion distance from the Sun amounts to 109.4 in terms of the Earth's mean distance, the semi-axis major of the orbit being 55.1, which is nearly double that of Neptune's.

Yours faithfully,

Blackheath, 1898, Sept. 19.

W. T. LYNN.

Black Spots in the North Zone of Jupiter.

GENTLEMEN,—

Although the result of my measures on Jupiter will soon be published in the Ast. Nach., I think that it may interest your readers to compare my measures of several dark spots in the north tropical zone with those published in your last number by Mr. Denning. His "Spot C" appears in my diary as "Chestnut Spot" on account of its colour, although its outlines resembled

* In Carl's 'Repertorium' this is erroneously referred to as vol. lviii.

the ancient "Violin Spot," at least in January. His "Spot A" has the name "New Violin Spot" in my diary, because I believed originally that it was the reappearance of the former so-called spot.

I must mention that the positions were determined by eye-estimation in January and April, but all others by micrometer measurements—generally of *both* contacts.

	1898.	New Violin Spot (Spot A).	Spot B.	Chestnut Spot (Spot O).	Spot D.
Jan.	19..	..	$\lambda = 293^{\circ}$	$\lambda = 329^{\circ}$	
	20..	$\lambda = 144.5$			
	23..	145			
	29..	..	..	327	
April	15..	..	273	300	
	25..	..	..	297.5	
May	2..	..	..	296	
	9..	..	..	293.7	
	10..	117			
	14..	..	..	293.25	$\lambda = 312.7^{\circ}$
	15..	114.8			
	16..	..	..	291	313
	21..	..	..	288.75	311
June	4..	..	238.5	280	
	21..	..	..	278	
July	17..	..	222		
	20..	..	..	274	
	22..	..	..	273	
	27..	..	..	271.5	
	29..	..	223		
Aug.	1..	..	..	268.5	287.5
	18..	..	..	263.2	

Lussinpiccolo, 1898 Sept. 14.

Yours faithfully,
LEO BRENNER.

The Recent Large Sun-spot.

GENTLEMEN,—

I measured the comparative radiation from the umbra of the large sun-spot on the 4th, 5th, and 9th inst., and the photosphere at the centre of the disc, by means of the Boys radio-micrometer. It is of interest to record the fact, that it was the darkest spot that I have yet observed. The mean value of 15 readings of umbra on the 4th gave 0.209, and 5 readings on the 5th inst. gave 0.24, and 6 readings on the 9th inst. gave 0.37. The values obtained on the 4th and 5th inst. are considerably lower than those obtained by the same apparatus from the great spot of August

1893*, which was 0.292, and which was the lowest value obtained until these later observations. I think it is probable that the higher readings on the 9th inst. may have been due to the "bridges" which were then thrown across the umbra, and from which the radiation would be large.

The spot was examined from time to time with the 6-inch refractor, and I was greatly struck with the difference of detail that could be seen by using different coloured glasses before the eye. By using a light green and a light red glass together, the detail that could be seen of the willow-leaf structure in the penumbra was magnificent, and the "bridges" were wonderfully sharp. On the other hand, by using only a deep red glass the penumbra was nearly invisible, but besides the "bridges" could be seen nebulous clouds lying over the umbra, which I am inclined to think were nothing but hydrogen prominences seen against the very dark background of the umbra, as when the spot was examined with the spectroscope the C line was bright over the umbra. The bright line seemed to me slightly deflected towards the violet end of the spectrum.

Yours faithfully,

W. E. WILSON.

Daramona, Streete,
Co. Westmeath,
1898 Sept. 14.

The suggested Variability of the Zodiacal Light.

GENTLEMEN,—

The paper of Mr. W. Anderson in the May number of the 'Monthly Notices,' p. 373, is interesting as showing the probability that the counterglow, or Gegenschein, of the zodiacal light varies in brightness. This is a point very difficult to prove owing to the fact that a slight difference in the condition of the atmosphere, or in the sensitiveness of the observer's eyes, makes so much difference in the appearance of the light; but, generally speaking, if the zodiacal band is very plain the counterglow is also plain, though I have at times noticed occasions when it has appeared very faint or indefinite, and I am inclined to think part of the variation is sometimes real. For example, on the 18th inst., at 14^h 15^m, though a very clear night, the zodiacal band in Aquarius and Pisces seemed to me very faint, and the counterglow was so little brighter that it was not easy to detect it. The observed centre proved, when the map and almanac were consulted, to be 1° f. the point opposite the Sun, which shows the possibility of a fairly correct observation in spite of the indistinctness of the phenomenon on this occasion. If simultaneous observations were made in far-distant places this question of variability might be settled.

Mr. Anderson, following Mr. Maunder, supposes that the part of the zodiacal light which will appear the brightest must be that

* 'The Observatory,' Sept. 1893.

where the particles are nearest "full." This presupposes that the particles are not very small. If they are very small, I apprehend the case would be very different; as, for instance, when one sees dust in the sunshine it is more luminous in the direction of the Sun than at a distance from it. Is not this quite likely to be the case with the zodiacal light? The extra light in the counterglow shows an increase of brilliancy in its direction, but probably this is not incompatible with a still greater brilliancy near the Sun.

West Hendon House, Sunderland,
1898 Sept. 20.

Yours faithfully,
T. W. BACKHOUSE.

Occultation of Mars, 1898 September 9.

GENTLEMEN,—

As I believe that comparatively few observations were made of the occultation of Mars which took place on the afternoon of the 9th inst., the following notes may perhaps be of interest.

I was able to observe the occultation at Outwood, Surrey, the instrument used being an 8-inch refractor. The sky was fairly clear, but there were thin clouds in some parts, particularly in the west. The Moon was not visible to the naked eye, but it was clearly seen both in the telescope and in the $2\frac{1}{2}$ -inch finder, the limb being well defined. In consequence of some thin clouds Mars was not seen until about 1.20 P.M., but it was then picked up and continued visible, except for a few seconds, up to the time of occultation. The planet was very faint, however, and after trying several eyepieces I found that it could only be held steadily with the very low power of 35.

Under these circumstances it was useless to attempt to observe first and second contacts, and I therefore observed bisection only. This I timed as occurring at $12^h 45^m 37^s.5$ Greenwich sidereal time. The planet and limb of the Moon were well defined at the moment of bisection. The approximate position of my observatory at Outwood (deduced from the ordnance survey) is lat. $51^{\circ} 11' 38''$ N., long. $0^{\circ} 5' 56''$ W. Clouds prevented the observation of the re-appearance of the planet.

Yours truly,

Kensington, 1898 Sept. 23.

W. H. MAW.

OBSERVATORIES.

CAMBRIDGE UNIVERSITY OBSERVATORY. — From Sir Robert Ball's report of the work done during the twelve months ending 1898 May 25, we infer that this institution is taking a little breathing-time. The zone of the *Astronomische Catalogue* is finished and published; it remains to publish the catalogue giving the individual observations of each star. Meanwhile these star-places are being improved by the re-observation of the stars

insufficiently observed, and this work, together with the observation of certain occultation stars, whose places are being supplied to Col. Tupman, and of Polaris to determine the adjustment of the instrument, make up the record of work with the meridian instrument for the year. A total of 2437 observations in both elements.

The Northumberland Equatorial has been used occasionally for gazing purposes, chiefly for the amusement and instruction of visitors. Mr. Hinks has given regular instruction in practical work.

As to the "new" astronomy, which is in the able hands of Mr. Newall, observations were made on 75 nights in the course of the year ending 1898 May 19 with the Bruce spectroscope mounted on the Newall telescope. With this combination 111 photographs have been obtained, giving material for the determination of velocity in the line of sight of 44 stars. Twenty of these stars are brighter than magnitude 2.5, and are included in the list of 51 stars for which the velocity in the line of sight was determined at Potsdam in the years 1888-1891. The remaining 24 stars are fainter than could be dealt with at Potsdam, the magnitudes lying between 2.5 and 4.0. The duration of exposure has been usually about 60 minutes. The reduction of these observations has been interrupted owing to Mr. Newall's journey to India to observe the solar eclipse, but 83 plates have been measured once, and 20 have been measured twice.

NATAL.—The astronomical work done at the Natal Observatory is becoming "small by degrees and beautifully less." It appears from Mr. Neville Nevill's report for the year 1897 that the only astronomical observations made during the year were those necessary for the ordinary purposes of the observatory, which we take to mean the time-service. It will be remembered that Mr. Nevill has a valuable lunar research awaiting publication, and there is in hand a comparison of declinations of stars observed in the northern and southern hemispheres, but these are not mentioned. The volume of 67 pages is filled up chiefly by meteorological observations made at various stations in the colony, which are tabulated by the observatory staff.

PUBLICATIONS.

STORIES OF STARLAND*.—Miss Mary Proctor, daughter of the late well-known astronomical author, has written a book somewhat after the Socratic method of the late Mrs. Markham. She addresses herself to her small brother and his cousin, who ask the right

* 'Stories of Starland,' by Mary Proctor. Potter and Putnam Company, New York.

question at the right time, and so are told a good deal about simple astronomy. We do not carp at this method, as in our opinion it commands the interest of juvenile readers, and the necessary shortness of the paragraphs is specially suited to their intelligence; still less can we quarrel with the matter of the book. In comparatively few pages Miss Proctor has managed to tell the salient facts about the universe—that the stars are suns, that suns and planets are evolved from star mist, that the Moon is cold, and what shooting-stars are made of. We might object to the view that the authoress takes of the canals of Mars, which she accepts as actual waterways with boats and barges. The small boy's theory that the circular spots where the markings cross are landing-stages deserves mention, and we may also quote his ingenious idea of sending his seventeen-stone uncle to Mars, where he would not weigh seven, as a neat way of conveying a fact to a juvenile mind. But the best part of the book is the legends and poems. Miss Proctor has collected stories about the sky from many sources; we find the story about the man who picked up sticks on Sunday, and was sent to the Moon; stories about the Great and Little Bear, and of the Rider on ζ Ursæ Majoris; Indian legends about the Pleiades; legends from Japan and from Sweden, and a great many more. Most of these are too long to tell here, and it is not fair to pick out an author's plums; but we take leave to quote a story of a different class to those enumerated, which Miss Proctor gives. Sir Robert Ball was showing Castor to a party of visitors, and very naturally mentioned that the components went round each other. Said one of his hearers who had been looking through the telescope, "O, yes, I saw them do so!" Besides the legends, there are scattered through the book many pretty little poems which have some connection with starland—among them is Dickens's 'Story of a Star'—culled from many authors. The book is tastily produced, and is evidently not expensive, but we do not know the actual price. Although intended primarily for children, our adult readers may thank us for calling attention to the book.

NOTES.

COMET NOTES.—A new comet (h 1898) was discovered by Perrine on Sept. 13, its place on Sept. 14^d 0^h 20^m.9 G.M.T. being R.A. 9^h 41^m 44^s, N. Decl. 30° 35' 19". Daily motion 6° East, 30' South. This comet was independently discovered on Sept. 14 by Chofardet at Besançon. It was then pretty bright, of the eighth or ninth magnitude.

The following elements have been deduced by Perrine and Aitken from observations on Sept. 13, 14, 15:—

T	1898 Oct. 20 ^h 02	Greenwich M.T.
ω	165° 17'	
δ	36 5	
i	29 12	
q	0.3842	

Almost identical elements have been deduced by Berberich.

Ephemeris for Berlin midnight (Ast. Nach. 3520).

R.A.				R.A.			
h m s				h m s			
N. Dec.				S. Dec.			
° ' "				° ' "			
Oct. 2....	11	41	0	15	39	Oct. 18....	13 29 48 6 10
4....	11	54	23	13 19		Nov. 3....	15 25 54 27 44
6....	12	7	49	10 51		19....	17 27 0 38 42
8....	12	21	17	8 15		Dec. 5....	19 12 30 40 36
10....	12	34	45	5 30			

The brightness on Sept. 30 is three times that at discovery, and increasing pretty rapidly. But after the middle of October it will be inconveniently near the Sun. After its reappearance it will be better placed for southern observers.

The comet was observed at Greenwich on Sept. 21, being then quite bright and visible in twilight; it was quite as easy to see as an eighth-magnitude star.

No. 63 of 'Publications of the Astronomical Society of the Pacific' contains a reproduction of the photograph on which Coddington's Comet was discovered. It was taken on June 9 last, and shows Antares and the beautiful nebulous region in its neighbourhood. The comet appears as a strong nebulous trail, from which the direction and rate of motion were inferred, and the comet was readily picked up by their aid. It had then a bright stellar nucleus, rather brighter than the eighth magnitude, surrounded by a nebulosity about 1' in diameter.

Mr. Coddington gives the following ephemeris for Greenwich midnight (Ast. Journ. 442):—

R.A.				R.A.			
h m s				h m s			
S. Dec.				S. Dec.			
° ' "				° ' "			
Oct. 4....	13	54	2	67 10	Oct. 24....	14 38 0	75 47
8....	13	59	41	68 47	28....	14 54 55	77 38
12....	14	6	29	70 28	Nov. 29....	23 9 13	80 24
16....	14	14	47	72 11	Dec. 31....	1 29 5	58 36
20....	14	25	3	73 58			

Brightness 0.48 on Oct. 4, 0.20 on Dec. 31.

Comets *b* and *e* 1898 (both discovered by Perrine) were visible in the same telescopic field on June 27, being only 15' apart. Comet *e* was of the 9th magnitude at the end of June, with a stellar nucleus of the 13th magnitude. Towards the end of July it grew much brighter and a tail developed.

Prof. Hussey examined Giacobini's Comet with the great Lick telescope on July 14. It had then a stellar nucleus of the 11th magnitude, a coma some 30" in diameter, and a well-developed tail 5' in length, which was narrow and pretty bright near the nucleus.

Herr Thraen continues the ephemeris for Wolf's Comet in *Ast. Nach.* 3518. It is for Berlin midnight:—

	R.A.			Dec.			R.A.			S. Dec.	
	h	m	s	°	'		h	m	s	°	'
Oct. 1..	6	39	28	3	33 N.	Dec. 4....	6	59	42	15	2
9..	6	49	37	0	59 N.	12....	6	53	5	16	12
17..	6	57	44	1	38 S.	20....	6	45	31	16	53
25..	7	3	42	4	15	28....	6	37	38	17	5
Nov. 2..	7	7	26	6	48	Jan. 5....	6	30	11	16	48
10..	7	8	50	9	14	13....	6	23	40	16	7
18..	7	7	55	11	29	21....	6	18	35	15	6
26..	7	4	49	13	26 S.	29....	6	15	9	13	52

The brightness is at a maximum, 2.66, on Oct. 14, and sinks to 11.11 by Jan. 29. The unit is the brightness at rediscovery in May 1891.

The comet was observed at Hamburg on Aug. 21 and 22 last. It was very faint, 1' in diameter, with a condensation of the 12th magnitude.

It was also accidentally observed by Pechüle at Copenhagen on Sept. 13, and was at first supposed to be a new comet, but the mistake was quickly detected.

A. C. D. C.

MINOR PLANET NOTES.—A new planet, DR, of the 11th magnitude, was discovered by Wolf at Heidelberg on Sept. 11. It was retrograding 36 seconds per day in R.A., and moving south 24' per day, so that it is probably one of the nearer members of the family. This rapid motion is confirmed by an observation two days later by Millosevich. This planet (apparently) has been named *Hungaria*.

Another planet, DS, was discovered by Wolf and Schwassmann also on Sept. 11; this was likewise of the 11th magnitude.

A third planet, DT, of the 12th magnitude, was discovered by Wolf and Schwassmann on Sept. 13.

A description of the orbit of the very interesting planet DQ is given in another column.

A. C. D. C.

THE ASTRONOMICAL CONFERENCE AT HARVARD: VARIABLE STARS.—A meeting of astronomers and physicists was held at Harvard College in August, which we believe was well attended. Of the interesting papers that were read there we might refer to one by Prof. Bailey, the point of which appears to be that in certain

star-clusters the proportion of variable stars is much larger than the proportion that prevails for the whole sky, but that this increased rate does not hold for all star-clusters. The following summary is from a Boston paper :—

The paper by Professor Bailey on variable stars contained a number of results of observations which have been carried on continuously since 1895, and formed probably the most important contribution to the literature on this subject which has yet been made. The observations to which the paper called attention were made with the thirteen-inch telescope with a sixteen-foot focal length, and all by photographic methods. Such success has been achieved in the photographing of close clusters that plates were obtained on which individual stars could be accurately studied. Photographs were made of Messier 3 and 5, and the great cluster in Hercules, in which strikingly different results were obtained, and it became at once apparent that while certain (globular) clusters contained variables in numbers vastly exceeding those yet found in other portions of the sky, other clusters, of similar size and form, contained few or no variables. At present twenty clusters have been examined. There are not sufficient data for the determination of the percentage of variables in all stars, but for stars brighter than magnitude 6.2 it may be stated approximately as one in a hundred. It would be dangerous to assume that this ratio is good for all stars visible to the telescope, however. The largest ratio, in Messier 3, is about one in seven, or fifteen per cent. In sixteen of the twenty clusters examined, the proportion of variables was less than one per cent. With the exception of certain special clusters, there is a smaller proportion of variables in the clusters than in the bright stars. It is possible that the proportion of variables among faint stars is in general small. One of the points emphasized was that there seems to be no relation between the distribution of the variables and their character, and it was also stated that the variables abound only in dense globular clusters.

If there were any doubt as to the actuality of the variability of the stars in these globular clusters, it would be set at rest by a note by Prof. Barnard in *Ast. Nach.* 3519. Being much interested in Prof. Bailey's work he determined to observe some of these variables with the 40-inch telescope of the Yerkes Observatory. Having been supplied by Prof. Pickering with a plate of Messier 5 with the variables marked, he chose seven at random, and after a series of observations each of which was found to be markedly variable. Prof. Barnard gives details about these stars in his note, and in a postscript he explains that he has since found that the first discovery of the variability of two of them was made by Mr. D. Packer, of London, who published his observations in the '*Sidereal Messenger*' as far back as 1890, but hitherto these variables have not been included in any catalogue. We think it due to Mr. Packer that this should be known.

TALKING of Harvard reminds us that in a chatty letter which we have been permitted to see, Prof. Barnard relates how he went to Harvard Observatory, and how much he was struck by the vigorous work that is being done there. He mentions also that Prof. Bailey showed him a plate of the Pleiades, taken with the Bache telescope at Arequipa, in the year 1897, with 5 hours'

exposure, which distinctly showed the nebulous streams, the existence of which is a matter of argument between Prof. Barnard and Dr. Roberts.

A MAGNETIC DISTURBANCE.—The abnormal movement of the magnets at Greenwich which took place on September 9 coincided in point of time with the passage of the great sun-spot across the central meridian. Beginning abruptly at noon on September 9, the magnetic movements at first were comparatively insignificant, but rapidly increased in magnitude after 2^h P.M., and became bold and decided. Briefly stated, the more important features of the disturbance were: a prolonged double wave in vertical force between 4^h P.M. and 11^h P.M., with superposed movements; a large and decided decrease in horizontal force between 7^h and 8^h P.M., followed by large and rapid fluctuations; and a bold double wave in declination between 7½^h P.M. and 9^h P.M., the movement extending through more than 1° of arc. These great salient movements were succeeded by sharp and rapid movements in all elements, the magnets becoming quiet in the morning hours of September 10, a few small movements occurring later in the day.

On the night of September 9 there was a brilliant auroral display, with numerous streamers till 9½^h P.M., and an arch afterwards till 11½^h P.M.

W. C. N.

LONDON UNDER A GREAT AUTUMNAL HEAT-WAVE.—London, in its history and associations, has much to be proud of, but probably it would be considered quite a new departure to point with pride to the fact that in the past month, in addition to its other calamities (notably a water-famine in the East), it has undoubtedly had more than a fair share of the great heat-wave which has recently visited these islands. But meteorological statisticians are a queer race, and are accustomed to receive all such additions to the store of exceptional records with the greatest equanimity.

This is the second time within four years that September has attained a pre-eminent place in meteorological annals. In September 1895 occurred that remarkable outburst of warmth towards the end of the month which was described at the time as "phenomenal," and during which not only the highest annual temperature was recorded, but a record was established for that part of the month of September greatly in advance of all preceding records. It will be remembered that a maximum temperature of 87°·3 was recorded in that month at Greenwich on the 24th, and that there were ten days in the month on which the temperature exceeded 80°. In the present year the great heat established in August has been continued and intensified in September. The hot weather began about August 11, and continued with very slight exceptions till September 23, a period of 44 days, during which

the mean daily temperature exceeded the average by no less than $6^{\circ}2$. It was essentially a bright, sunny, rainless period, with a few welcome breezes somewhat tempering the great heat. As in September 1895, there were ten days in this month with temperatures exceeding 80° , the highest having been $92^{\circ}1$ on the 8th, the maximum for the year. A temperature of $92^{\circ}1$ has once before been experienced in September, viz. in 1868, on the 7th, but as that hot day came at the end of an exceptionally hot summer, it did not stand out quite so oppressively. The mean temperature for the hottest day this year (Sept. 8) was $76^{\circ}4$, which is $17^{\circ}7$ in excess of the average, and there were three other days in September with mean temperature in excess of 70° , viz., the 7th, 9th, and 17th, when the mean daily values were respectively $70^{\circ}5$, $75^{\circ}3$, and $74^{\circ}8$. That this is very exceptional may be seen from the fact that there have been only five days with higher means than 70° recorded in September in the 57 years 1841–1897, the highest having been $72^{\circ}3$ on the 7th September, 1868. Taking all days in the whole period 1841 January to 1898 September (about 21,000 days), the mean for September 8th, 1898, ranks as seventh in order of magnitude, having been exceeded by the values on July 15th, 1881 ($78^{\circ}4$), July 22nd, 1868 ($78^{\circ}3$), August 18th, 1893 ($77^{\circ}9$), June 16th, 1858 ($77^{\circ}3$), August 13th, 1876 ($77^{\circ}2$), and July 12th, 1859 ($76^{\circ}8$).

Rainfall has been very deficient in September, the amount measured up to and including the 27th being 0.14 inch on three days only, the year's rainfall 1897 October–1898 September being nearly 10 inches less than the average amount. W. C. N.

THE TELESCOPE FOR THE PARIS EXHIBITION OF 1900.—Details about the monster instrument which is to be one of the attractions of the next great show in Paris are beginning to be published. The aperture is to be 49.2 inches, and the focal length 196 feet 10 inches, and the estimated cost is 1,400,000 francs. The instrument, which is being made by M. Gautier, will not be mounted equatorially, but will be fed by some sort of *cœlost* or *heliostat*.

THE APPARENT SIZE OF THE SUN NEAR THE HORIZON.—Referring to the article on this subject in our last number, it has been pointed out to us by Capt. Noble that the question has been investigated by M. Paul Stroobant, who published two valuable papers in the 'Bulletin of the Brussels Academy' in the years 1884 and 1885. One conclusion M. Stroobant arrived at was that the apparent augmentation of the discs near the horizon does not depend on an apparent ellipticity of the celestial sphere, for this ellipticity is not appreciable to everyone, although the augmentation is. M. Stroobant found, from a series of ingenious experiments, that the distance to which one mentally refers an object is the same whether it be at

the zenith or at the horizon; he thought that the effect is physiological, and is the result of the variation of brightness of the object.

ASTRONOMICAL BLUNDERS OF NOVELISTS.—An American reader of Miss Marie Corelli sends us the following example of an error in astronomy to be found in her novel 'Barabbas':—

Friday: the great darkness of the crucifixion evidently, in her opinion, was not due to an eclipse, for in chapter xxviii., on the next evening, the Moon was full: ". . . and glanced up at the Moon that shone, *round and full*, in at her open casement."

As all these eventful days were, according to common acceptation, in the spring, the full Moon would have risen within an hour or so of 6.0 P.M. on the above-mentioned Saturday. But in chapter xxx. we find: ". . . Towards *three o'clock in the dawn* of the Jewish Sabbath . . . the Moon had disappeared . . . leaving but a silvery trail . . ." That this was still the full Moon is confirmed by chapter xxxv.: ". . . the Moon, large as a golden shield, suddenly lifted herself above the city . . ." just after sunset, as is shown by the context. Only eight evenings later chapter xlviii. reports "the broad lustre of a full Moon spreading itself like powdered silver." In one week more, or a fortnight after the full Moon was lighting up Barabbas's dungeon, "the same narrow line of light was piercing the thick obscurity! It fell from the Moon, a pure stream of silver."

Thus it would seem that the author has carefully preserved that same "full Moon" for two weeks, though with sudden and only momentary variations in the interim to make it interesting to astronomers.

H. S. D.

We understand that when M. Folie resigned the Directorship of the Royal Observatory, Belgium, it was considered a good opportunity to separate the astronomical and meteorological branches. On September 2nd the king signed the following appointments:—

Director of Astronomical Branch . . .	M. C. Lagrange.
Director of Meteorological Branch . .	M. A. Lancaster.
Administrator-Inspector	M. P. Goedseels.

The office of the latter embraces the general management of the Observatory, the care of instruments and buildings, and the financial arrangements.

THE most recent volume of the Smithsonian Collections (vol. xl.) may be found useful to astronomers and other persons who wish to consult scientific literature. The contents of the book are described by its title, 'A Catalogue of Scientific and Technical Periodicals, 1665-1895, together with Chronological Tables.' This is a second edition, and we hope more "up-to-date" as a

whole than in one particular instance we looked out. The Editorship of this Magazine is given as though it had not changed since 1881.

WE have received a copy of the newly-revised edition of Dr. C. A. Young's 'Text-book of General Astronomy.' We hope to say something of this in our next number.

WE have reason to know that certain persons in authority are making an endeavour to substitute Greenwich Time for Dublin Time for general use in Ireland.

THE astronomy at the British Association was confined to a discussion on the recent solar eclipse, carried on by Prof. Turner, Sir J. N. Lockyer, and Capt. Hills.

FROM AN OXFORD NOTE-BOOK.

THE Bristol meeting of the British Association was a great success. The weather was brilliantly fine, though rather hot for some of the crowded rooms; and the burning of the Colston Hall a few days before it was to have been the scene of important ceremonies, instead of in any way crippling the Executive, seemed only to be an opportunity for showing resource. The new auditorium, taken at a few days' notice for the President's Address and the Lectures, was the "People's Palace," and a few of us who sat near the doors heard occasional expostulations from members of the usual audience, who could not understand their exceptional exclusion. On the night of one of the lectures Miss Cissie Loftus was to have appeared there; and I tremble to think what it must have cost in compensation. We had a typical and a first-rate President's Address: typical because we had firstly one of the old scares, this time about the food-supply; secondly, an interesting summary of recent work on certain lines; thirdly, the announcement of a new element (discovered by the President—xenium, the stranger element); and fourthly, a little apologia by the President, *apropos* of spooks. One or more of these items is in every President's address; but seldom has the four-in-hand been driven so well as by Sir William Crookes.

As regards Astronomy we had not much beyond a "discussion meeting," on the recent solar eclipse (or, as a local paper had it, the recent *polar* eclipse expedition); a joint-meeting of Sections A (mathematicians+physicists) and B (chemists) arranged at the request of the latter. The results are not yet fully worked out, and little more could be said than has already appeared in print, though something was done in the way of collation. Sir Norman Lockyer startled us, however, by declaring that the spectrum of the "flash" was the same as that of γ Cygni, a fact which he called the Rosetta stone of solar physics; and if this coincidence

is established his analogy is in no way strained. The two spectra were thrown on the screen in juxtaposition, and as far as I could see (and I was close to the screen) in a rapid glance the coincidence was practically perfect. But I speak with very slight knowledge in such matters.

In departments allied to Astronomy we had an International Conference on Terrestrial Magnetism, which went well in the able hands of Prof. Rücker as President. There seems some hope of keeping some of our magnetic observatories undisturbed by electric railways; and of measuring the velocity of transmission of magnetic disturbances. Also of getting several new observatories in places where they are badly needed. Then we heard from Prof. Milne that he has got 25 seismological observatories well distributed over the globe—"all British"—and work is already begun. And among other interesting items I must not forget Prof. Callendar's beautiful sunshine recorder, which gives the radiation at any moment in the form of a curve on a drum; and the total radiation up to that moment by a little planimeter wheel which automatically integrates the curve. But there was so much of interest that it seems invidious to specify. We seemed to have every day full to the Wednesday, when we had a merry trip down the Avon and back to visit the fleet anchored in the Bristol Channel. But there was no Red Lions' Dinner!

An attractive programme is sketched by Prof. Pickering in *Ast. Nach.* No. 3510. It is hoped to "secure a complete list of all variable stars brighter than the ninth magnitude at maximum whose variation exceeds half a magnitude, and whose period is less than a day." As in other instances of work originated at Harvard, the striking feature of the scheme is its comprehensiveness, which would amaze us but for the fact that Prof. Pickering has himself accustomed us to expect it from him. The whole sky down to the ninth magnitude is to be dealt with by two observatories, Harvard and Arequipa (if, indeed, it would not be fairer to say one observatory alone, regarding Arequipa as an auxiliary observing station only); and we are told that 40 plates only will be necessary to do this, each plate covering a region about 33° square. The plate is to be automatically exposed at regular intervals with an imperfectly adjusted equatorial, so that ordinary stars will show a string of images of uniform size. But for short-period variables the string will show faint portions or actual gaps; and such stars can thus be detected by a mere inspection of the plate. A portion of such a plate actually taken is reproduced, showing the known variable U Cephei.

THE question naturally suggests itself, how far such a scheme would be applicable to the discovery of long period variables. The exposures would have to be given at intervals of some days

instead of some minutes, and it would be a tedious and risky business either to keep the same plate in the telescope all the time, or put it in and out when wanted. But this might be got over by taking a series of plates in the ordinary way, and then copying them all on to one plate, so that the images formed a series; a method applicable also in cases of parallax work or for the detection of proper motions. But a more serious difficulty would probably be the irregular variations in photographic effect on different nights. Even the same night is by no means constant in quality; though the changes are usually small or at least gradual, so that the strings of images for normal stars would be nearly uniform. For a series of plates on different nights the want of uniformity might be serious, unless means were taken to compensate it. This would be troublesome but by no means impossible; for instance a trial photograph might be first taken to test the quality of the night, and the exposure then regulated accordingly. Anyone who is looking for a piece of work on which to try his teeth might do worse than think out something on the lines suggested by Prof. Pickering's scheme. A modest equipment (the lens of an ordinary camera?) might be sufficient.

How the idea of examining a region 33° square all at once would have startled astronomers of half a century back! accustomed as they were to a (visual) field of a few minutes only. Even to us it is sufficiently surprising. It takes some time to shake off old habits; and I don't think we have yet shaken off the idea that our telescopic field must be a small one as thoroughly as the photographic method demands that we should. So long as we stick to an achromatic object-glass, or the parabolic reflector, it seems tolerably clear that we can only deal with a region 2° square at most. But why should we be thus limited? It has always been feared that the optical distortion of a photographic doublet or triplet would make a plate taken with such an instrument unfit for accurate measurement; or that at least very troublesome corrections would be required. For this reason, among others, the suggestion of Prof. Pickering to use photographic doublets for the Astrographic Chart was rejected by the International Conference at Paris in 1887, and the achromatic object-glass was adopted. The decision was prudent, because no information was forthcoming at the time as to such optical distortion, and (so far as I know) little or nothing has been published on the subject since. But from some measures recently undertaken at Oxford, and approaching completion, I believe it will be found that stars are photographed at Harvard over a region at least $5^\circ \times 5^\circ$, with an optical distortion which is quite small and easily manageable; and I am now probably understating the truth. Thus the sky could be charted with, at most, one-sixth the number of plates, without loss of accuracy for measuring purposes, which is an important consideration.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

NOVEMBER, 1898.

No. 272.

Comparison between the Observed and Predicted Motions of the Pole.

IN A. J. No. 446, Dr. Chandler has discussed the latest observations made for latitude variation during the last eight or nine years to ascertain what improvements can be made in the numerical values of the elements involved in the geometrical expression of his law of latitude variation. The observations consist of 29 series of observations made at 18 different stations, and the whole data are arranged under three different groups of longitudes, and are so reduced as to be referred to the three different meridians of Kasan, Berlin, and Bethlehem. A chart is given showing the comparison between the observed and computed latitude variations for the three groups thus arranged.

Dr. Chandler discusses the observations as corrections to his calculated values, and gives two diagrams comparing the observed and computed values, from which it is manifest that the observed and computed curves are essentially identical in general character, and what small differences are shown to exist point to the need of some slight modification of the numerical constants, and not to a want of correctness of the geometrical theory. After 1896 it appears that the observed position of the pole is systematically behind the theoretical position by an amount corresponding to about 15 to 20 days' motion in the orbit.

The problem Dr. Chandler set himself was to determine from the observed co-ordinates x and y , which are entirely independent of theory, the numerical values of the constants expressing the periods, epochs, and parameters in his fundamental equations; and as this problem was not entirely resolvable from the present short series, Mr. Chandler has availed himself of all the best material available since 1825 on the following five assumptions:—

- I. Eq. (52) of the investigation in A. J. 322 identical with eq. (36) of the synopsis of the theory in A. J. 406.

- II. The best period variable uniformly with the time which will unite the epoch of the present series with the rest of the data in the Table except A, viz.:

$$2412646 + 427.0 E - 0.08 E^2.$$

- III. The best similar representation for the dates since 1860 with a uniform period, viz.:

$$2412646 + 428.2 E.$$

- IV. The formula of H. G. v. d. Sande Bakhuyzen in A. N. 3275, viz.:

$$2412672 + 431.55 E.$$

- V. The formula recently given by E. F. v. d. Sande Bakhuyzen in the 'Proceedings' of the Amsterdam Academy, viz.:

$$2412660 + 431.11 E.$$

The testimony of the observations as to the variability of the period of the 428 day term is given in the following table (p. 395), from the six normal epochs formed as indicated by the letters in the fifth column, together with the variations of the assumed hypotheses under O—C.

From these data Dr. Chandler concludes:—

- (a) That the velocity of rotation in the 14-months' period is not uniform.
- (b) That the mean period since 1825 is 428 days within a fraction of a day.
- (c) That the hypothesis that the mean period since 1860 is 431 days is untenable.
- (d) That the hypothesis of a change in the period uniform with the time while it accords with observations since 1860, is incompatible with those anterior.
- (e) That a change *per saltum* between 1830 and 1860 is also incompatible with the facts, which are best represented by his adopted formula.

Taking the period for the series under discussion, 1890-97, as 427.0 days, which corresponds to an angular velocity of $\theta = 0^{\circ}.843$, Dr. Chandler deduces the following values for the 14-month term, viz. :—

E.	Observed T_1 .	O—C.	Observed r_1 .	O—C.
—3	2411363	— 3	0.179	+0.010
—2	1788	— 3	0.149	—0.013
—1	2222	+ 8	0.155	0.000
0	2651	+13	0.145	—0.003
+1	3060	0	0.138	—0.003
+2	3503	+20	0.125	—0.009
+3	2413946	+40	0.103	—0.024

Observatory.	Instrument.	Interval.		Observed Period.	O - O.				
					I.	II.	III.	IV.	V.
A. Greenwich.....	Mural Circles.	1825-36	B - A	d 418.5	d -4.8	d -16.2	d -9.7	d -13.0	d -12.6
B. { Greenwich..... Pulkowa Pulkowa	Mural Circles. Prime Vertical. Vertical Circle.	1836-50 1840-55 1842-49	O - B	433.1	+1.4	+1.1	+4.9	+1.6	+2.0
O. { Pulkowa Leyden Pulkowa	Vertical Circle. Meridian Circle. Vertical Circle.	1863-70 1864-74 1871-75	D - B	432.0	+0.1	+0.5	+3.8	+0.5	+0.9
D. Pulkowa	Prime Vertical.	1875-82	E - O	429.1	-1.2	0.0	+0.9	-2.4	-2.0
E. { Pulkowa Lyons	Vertical Circle. Meridian Circle.	1882-89 1885-93	F - D	428.5	+2.0	+0.4	+0.3	-3.0	-2.6
F. Present series ...	Talcott Method.	1890-97	F - E	427.2	+2.7	-0.3	-1.0	-4.3	-3.9

The last value is from an incomplete cycle, and therefore uncertain. The solution for the whole series gave as the mean values (1890-97.5):

$$T_1 = 2412646, \quad r_1 = 0''.148.$$

The differences O—C are the variations of the numerical theory of A. J. 322, where

$$T_1 = 2412638, \quad r_1 = 0''.156$$

for the mean epoch with a period of $423^d.1$. The above residuals imply a correction of about $+5^d$, thus the observed period is 428 days; but this is uncertain, inasmuch as it involves the assumption that the annual period is exactly a year.

Dr. Chandler has satisfied himself that the observed diminution in the values of r_1 are due to a real diminution in the radius of the circular motion, and not to the annual ellipse. In any case its agreement with the empirical law derived from the observations of 1825-90 is quite striking.

The elements of the annual ellipse given by the investigation are shown in the following table, and do not differ materially from the mean value. A tendency to progression in the elements belonging to the epoch and position of the major axis is noticeable, but not large enough to pronounce as to its reality, considering the delicacy of the problem, and a decision on the point must be left to future observation.

	T.	L.	W.	<i>a</i> .	<i>b</i> .
1890	March 29.....	7	43	0.27	0.13
1892	April 3.....	13	48	0.32	0.08
1893	March 31.....	9	40	0.26	0.09
1894	April 10.....	19	48	0.26	0.08
1895	March 29.....	7	30	0.30	0.09
1896	April 13.....	23	37	0.27	0.07
1897	April 25.....	34	26	0.33	0.11
All.	April 8.....	17.1	39.6	0.275	0.085
Adopted value(A. J. 329).	April 6.....	15	45	0.30	0.08

From collateral evidence Dr. Chandler deduces some reasons why it is probable that a change of some sort in the position of the annual ellipse must be in progress, and that the observed changes may be due to an apsidal motion of the ellipse. Meanwhile Dr. Chandler, for the purposes of computation of latitude variation, assumes all the elements of the ellipse as constant, and finally concludes that, with the exception of the correction to the epoch T, the differences in his adopted values are merely nominal. Thus, if we suppose the epoch II., p. 394, corrected by

$$\Delta T_1 = +8^d + 1^d.8 \text{ E,}$$

The remaining differences are nearly

$$\Delta x = -0''.010 \sin(t - T_1)\theta + 0''.008 \sin(\odot - 291^\circ).$$

$$\Delta y = -0''.010 \cos(t - T_1)\theta + 0''.005 \cos(\odot - 0^\circ).$$

If these are ignored the tables for latitude variation published in *A. J.* 360, 392, and 426 may still be used by entering them with the argument of the observed date diminished by

8 days in 1893			13 days in 1896		
10	„	1894	15	„	1897
12	„	1895	17	„	1898

The values thus found will generally not differ more than $0''.01$, never more than $0''.02$, from the revised formulas, differences which are purely nominal. Assuming then it be granted that the Earth's axis is subject to a composite motion arising from a uniform circular motion in 428 days, and a very eccentric central elliptic motion obeying the law of proportionality of times to areas about a mean position on the Earth's surface, Dr. Chandler finds that his theory represents observation within $\pm 0''.03$, so that it may be considered exact within the limits of possibilities of error of observation; and he therefore considers that if his theory is to be called empirical, it is only empirical in the sense that it rests entirely on the experience of observation, and is not a deduction from principles.

W. G. THACKERAY.

A Contribution to the Theory of Motion of the Leonids.*

ON account of the approaching return of the Leonids a discussion of the above subject merits some attention. Observations of useful value connected with it having been only made thrice—in 1799, 1833, and 1866, or rather only once, in 1866—our knowledge of details of the orbital motion of the Leonids is very scanty. Particulars of the radiant-area, of the orbit's elements and of the native origin of the Leonids, and of many minor features of the stream, are all wanting. But the orbit-elements of the stream's parent comet (Tempel, 1866 I.) are well known as given by Oppolzer in *Ast. Nach.* 1624. Whatever motions the Leonids may have, to examine the perturbations of this comet's orbit is thus clearly of importance to afford us an insight into those which the meteor-stream may undergo. At the revered request of Dr. Bredichin, I therefore undertook that calculation. The secular perturbations of Comet 1866 I. were calculated by the formulæ and tables given by G. W. Hill in his work 'On Gauss's Method of Computing Secular Perturbations.' Newton and

* We are indebted to Prof. Alex. S. Herschel for this slightly abbreviated translation of two important papers by Dr. E. Abellmann which appeared in *Ast. Nach.* 3516.

Adams, as is well known, resolved the problem of the secular disturbance, the first finding, from historical accounts of the star-shower, a motion of its node of 29', the second astronomer, using Gauss's method of calculation, arriving at a motion of 28' (Jupiter 20', Saturn 7', and Uranus 1'). Following Hill's method, I divided the circuit of the orbit into 36 parts of 10° of excentric-anomaly, and computed the perturbations produced in the orbit at 36 points corresponding to them, its great excentricity requiring the orbit's subdivision into a large number of small portions. Oppolzer's elements were used; and a synopsis of the whole calculation will before long be published in detail. The following were the results obtained, the whole secular disturbance produced in one $33\frac{1}{4}$ -years period by the different planets being :—

	By Jupiter.	By Saturn.	By Uranus.	
$\delta\Omega \dots$	+ 22'.447	+ 4'.555	+ 48''.8	The other planets all exerting no sensible effects. The whole sums are.....
$\delta i \dots$	+ 48''.2	— 33''.6	— 57'.3	
$\delta\pi \dots$	— 2'.338	— 1'.319	+ 6'.9	
$\delta e \dots$	+ 0.00006	± 0	± 0	
				+ 27'.8 — 42''.8 — 3'.5 + 0.0000

The perturbations of the *Period* were not calculated, on account of the large size of the cometary mass. The close agreement of my result with those of Adams and Newton seems to indicate that the orbits of the meteors and of the parent comet have nearly coincided with each other from a very remote time.

The computed quantities $\delta\Omega = +27'.8$ and $\delta\pi = -3'.5$ give $\delta\omega = -31'.3$, or the perihelion's secular motion is about $1^\circ.5$ in 100 years, and as the stream has been observed for about 1000 years its line of apses has revolved in that time about 15° ; but a glance at the form of the orbit shows that this motion of the apse would alter the solar distance of the stream at the descending node very little from the Earth's distance from the Sun, so that for many ages yet the continued visibility of the star-shower will not be thereby affected.

The "November Comet," 1866 I., arrived at its descending node 1866.06, and the Earth passed through the same point 1866.87; at the first of these moments the comet's true anomaly was 9° , and at the second it was 127° . We may probably enough conclude from this that the comet is followed in its course by a train of dense matter about five times the Earth's distance from the Sun in length (a result of the stream's length which is easily deduced by considering the form of the comet's orbit). But in front of the comet there seems to be no similar appendage, as at its passage through the node in 1865 the Earth was comparatively at a much smaller distance from the comet, and notwithstanding that, meteors were observed then in only slight abundance. At the Earth's passage through the node in 1867 again only a meagre meteoric

Display was visible, so that the dense stream behind the comet does not exceed seven Earth's distances from the Sun in length, or about one-seventh part of the whole length of the comet's orbit. Abelmann does not appear to have appreciated the importance of the splendid showers of Leonids observed in America both in 1867 and 1868.]

Remarks on the Bielid Meteors.

After a maximum on 1885 November 27 it is well known that the Bielids were observed again in less numbers on 1892 November 23. This 4° displacement of the node was produced, as shown by Dr. Bredichin in his report "On the Orbit of the Bielid Meteors" ('Bulletin de l'Académie de St. Pétersbourg,' t. vii. liv. 3), by Jupiter's disturbing action during the years 1889.5–1891.5. If we follow the Bielids in their later movements, from their configuration relatively to the position of the planet Jupiter we can be assured that their orbit, from 1892 to 1898, has undergone no deformation capable of being detected by meteoric observations. This can readily be perceived in a diagram of the two paths by comparing together Jupiter's and the Bielids' positions in their orbits during that interval; and as all the other planets exert no sensible effect upon the meteors' orbits, it may be expected that the Bielids will return again this year on November 23, and in a denser shower than in 1892, as it is known that the maximum of the Bielid shower occurs most conspicuously every 13 years.

The orbit-motion of the Bielids will be strongly deflected about 1901.2, when they will approach to about 0.5 of the Earth's distance from the Sun from Jupiter. Dr. Schulhof has already noted this conjunction in his paper "Sur les Étoiles Filantes" ('Bulletin Astronomique,' t. xi. 1894), and to compute the disturbance I have used the elements given by Bredichin (in his above-mentioned paper) of the orbit of the Bielids, and calculated the displacement of the lines of nodes in the interval 1900.8–1902.2. The mode of computation used was that for "special disturbances" with the set of formulæ devised for such a case by Dr. Backlund in his work 'Calcul et Recherches sur la Comète de Encke (II. Résumé des Formules, 7),' and I divided the whole time-interval into 15 equal parts of $36\frac{1}{2}$ days each. The 'Berliner Jahrbuch,' 1900, and Le Verrier's Tables give Jupiter's positions. I thus obtained $\delta\Omega = -6^\circ.2$. Thus, in all probability, the next great maximum may be expected to take place on 1911, November 17, while a lesser maximum display of the Bielid shower may be looked for on the same date, November 17, in one of the years 1904 or 1905. The details of this calculation will, it is hoped, be published in the Russian language before long, in a special volume.

Meteoric Showers in September and October from the Region of Hercules, Draco, and Cygnus.

DURING the last half of September and early part of October observers record the occasional appearance of very slow-moving, trained meteors, directed from radiant in the south and western region of the sky. I have seen many of these meteors since 1875, and have secured a sufficient number of path-observations to ascertain some of their various radiant-points amongst the stars in Hercules, and, further to north and east, in Draco and Cygnus. Below I give a summary of the positions, and, side by side with them, a number of similar radiant points observed here in the several earlier months of January, April, and July:—

Sept.-Oct.	Approximate star.	January.	April.	July.
$230^{\circ} + 52^{\circ}$	ϵ Draconis.	$230^{\circ} + 52^{\circ}$	* $233^{\circ} + 47^{\circ}$	$\begin{cases} \circ & \circ \\ \text{.....} & \end{cases}$
$242 + 48$	τ Herculis.	$240 + 48$	$239 + 46$	$\begin{cases} 242 + 49 \\ \text{Aug.} \end{cases}$
$253 + 54$	μ Draconis.	$253 + 56$	$254 + 57$	$\begin{cases} 253 + 54 \\ 255 + 37 \\ 258 + 37 \end{cases}$
$255 + 37$	π Herculis.	.....	$255 + 37$	$\begin{cases} 256 + 26 \end{cases}$
$256 + 26$	δ Herculis.	$250 + 25$	$256 + 25$	$\begin{cases} 256 + 26 \end{cases}$
$263 + 61$	ζ Draconis.	$261 + 63$	$\begin{cases} 263 + 62 \\ 260 + 62 \\ 270 + 48 \end{cases}$	$\begin{cases} 260 + 63 \end{cases}$
$270 + 47$	γ Draconis.	.....	$\begin{cases} \text{Mar.} \end{cases}$	$\begin{cases} 270 + 47 \end{cases}$
$271 + 22$	η Herculis.	.....	$272 + 21$	$\begin{cases} 271 + 22 \end{cases}$
$293 + 31$	β Cygni.	.....	.....	$\begin{cases} 289 + 31 \end{cases}$
$304 + 40$	γ Cygni.	.....	$\begin{cases} \dagger 307 + 40 \\ 316 + 46 \\ \text{Mar.} \end{cases}$	$\begin{cases} 303 + 39 \\ 301 + 41 \end{cases}$
$313 + 48$	α Cygni.	.....	$\begin{cases} \dagger 314 + 49 \end{cases}$	$\begin{cases} 315 + 49 \\ 314 + 48 \end{cases}$
$316 + 59$	α Cephei.	.....	$\dagger 316 + 61$	$\begin{cases} 313 + 60 \\ \text{June.} \\ 311 + 62 \\ \text{Aug.} \end{cases}$

* Derived from Zezioli's observations in 1869.

† Derived chiefly from Weiss's Austrian observations, 1867-74.

The positions of the last six radiant in the table are very unfavourably situated for observation in January, and they do not appear to have been recognized, even if visible, by anyone.

The radiant of these September Herculis, Draconids, and Cygnids are pretty sharply defined, and it is rather unusual to recognize fairly strong radiant in positions so far removed from the apex of the Earth's way. The best shower of them all, as regards the brilliancy of the individual members, is the first in the list, which falls in Bode's constellation "Quadrans Muralis,"

between the stars α Draconis and β Boötis, and is rather nearer to the former. Curiously enough, it occupies the same apparent point as the well-known January Quadrantids (max., Jan. 2), and precedes the latter in date just three months, for the former presented a strong maximum in 1877 on October 2. I have registered the following meteors from it:—

*Quadrantids of September–October ($230^\circ + 52^\circ$) *.*

Date.	G.M.T.	Mag.	Path.				Length.	Notes.
			From		To			
			$\alpha.$	$\delta.$	$\alpha.$	$\delta.$		
	h m							
1885 Sept. 17 ...	15 24	3	68 $\frac{1}{2}$	+51 $\frac{1}{2}$	64 $\frac{1}{2}$	+34 $\frac{1}{2}$	17	Slow.
1876 20 ...	9 20	2	322	+31	332	+21	13	Swift; train.
1886 20 ...	9 53	5	351	+27	359	+16	13	Slow.
1898 22 ...	8 45	2	228	+70	225	+81	11	V. slow; train.
1884 22 ...	13 6	3	30	+20 $\frac{1}{2}$	34 $\frac{1}{2}$	+4	17	Slow.
1887 24 ...	11 56	4	235	+80	47	+10	90	V. v. slow; train; flight 13 $\frac{1}{2}$ sec.
1886 27 ...	13 52	3	125	+62	104	+43 $\frac{1}{2}$	22	V. slow; train.
30 ...	11 38	1	25	+89	39	+81 $\frac{1}{2}$	8	Slow.
1877 Oct. 2 ...	8 59	♀	325	+67	354	+48	24	R. slow; train visible 3 $\frac{1}{2}$ minutes.
2 ...	9 26	3	257	+85	22	+84	10	Slowish.
2 ...	9 32	3	270	+37	284	+22	19	Swift.
2 ...	9 47	4	203	+40	198	+36	6	Slow.
2 ...	10 0	2	192	+53	181	+50	7 $\frac{1}{2}$	Slow.
2 ...	11 18	1	230	+43	233	+39	4 $\frac{1}{2}$	Slow.
1880 2 ...	7 50	2	233	+61	236	+74	13	V. v. slow; train.
2 ...	8 0	1	223	+43	221	+41	3	Swift.
1877 4 ...	7 29	3	225	+43	224	+37	6	Swift.
16 ...	15 38	2	168	+45	152	+36	15	Slow.
16 ...	16 30	4	204	+66	87	+37	66	V. slow; train; flight 9 sec.

I noted only one meteor belonging to it during watches from September 15 to 23 in the present year, but several of the other radiants were in more active evidence.

These early-autumn showers will well repay observation at future returns. They often supply conspicuous meteors moving in long paths, and slowness of motion is a usual, though, apparently, not an invariable feature.

Bristol, 1898, Sept. 24.

W. F. DENNING.

* The place adopted for this radiant from the data obtained in 1877 was at $225^\circ + 52^\circ$ ('Monthly Notices,' xxxviii. p. 312, and l. p. 450), but several later observations of meteors, favourably placed for indicating the R.A. accurately, show that this position is a little west of the correct centre.

CORRESPONDENCE.

*To the Editors of 'The Observatory.'**The recent Large Sun-spot.*

GENTLEMEN,—

I have read with much interest the letter of Mr. W. E. Wilson on this subject which appeared on page 379 of your last issue, and I am in thorough agreement with his remarks as to the extent to which the delicate details of sun-spots are masked by the use of unsuitable coloured glasses on the eyepiece. I have experimented with a variety of solar eyepieces, such as first-surface reflecting prisms used singly and two in succession, polarizing eyepieces, &c., but I have found no arrangement which gives such perfect views of detail as the Dawes eyepiece. As with this eyepiece it is possible to cut off all the light except that from the small portion of the solar surface under immediate observation, it follows that screen-glasses of comparatively light tints are required, and thus delicate details, which would otherwise pass unnoticed, become readily visible.

Moreover, in the case of a large spot, like that to which Mr. Wilson refers, it is quite possible, by employing the smallest aperture on the diaphragm plate, to examine the umbra alone, the penumbra being stopped out of the field. When thus examined under favourable circumstances the umbra ceases to appear as a uniform black spot, but becomes a spot veined by delicate brighter shading.

Mr. Wilson refers to the "willow-leaf" structure in the penumbra, and to the brilliant "bridges" of the recent spot; and in connection with these "bridges" I should like to call attention to a feature which I have, during the past few years, noticed in the case of quite a number of large spots, but which does not appear to have been discussed by solar observers generally, although it can scarcely have escaped notice. This feature is that in addition to the well-known brilliant "bridges" the umbra of a spot is sometimes crossed—or partially crossed—by what I have called, for want of a better name, "veiled bridges." The appearance of these "veiled bridges" conveys the impression that they are situated at a lower level than the ordinary bright "bridges," and they have in fact the appearance which the ordinary "bridges" might be expected to show if submerged in a mass of light-obscuring vapour.

These "veiled bridges" require a fairly powerful telescope to show them—I have not seen them clearly with less than 6-in. aperture—and they cannot be seen well unless means are adopted to screen off the bright light of the adjacent solar surface. On September 11 between 2.30 and 5 P.M., when observing the recent large spot with my 8-inch refractor at Outwood, some beautiful examples of these "veiled bridges" were seen, but none of them

extended completely across the umbra. On the southern side of the leading spot of the group a very curious formation was noticed, two bright lines of faculae appearing to flow from the surrounding photosphere over the penumbra. On reaching the inner edge of the penumbra each of these lines branched, one branch in each case extending out over the umbra, and forming the commencement of a brilliant "bridge," while other branches appeared to curve downwards into the umbra and form "veiled bridges" of greater or less extent. During portions of the afternoon the air was very steady and definition excellent, and at such times the details of the spot were exquisitely beautiful.

As for the umbra, when examined with a very small aperture in the diaphragm plate (about $\frac{1}{130}$ inch in diameter, equivalent to about 14 seconds of arc in my telescope at Outwood) so as to shut out the surrounding penumbra, no portion of it appeared really black.

Yours sincerely,

W. H. MAW.

Kensington, 1898, Oct. 10.

[RETURN OF THE GREAT SUN-SPOT.—True to its time the great sun-spot returned on Thursday, September 29. The great spot was, however, preceded by a considerable group some 20° preceding it in longitude, and 6° nearer the equator in latitude, causing the great spot to appear rather as the last of a long stream than as its leader, as it had been during the previous apparition. The chief spot had shrunk in size considerably during the fortnight which had elapsed since its disappearance at the west limb, its area now being but 700 (expressed as usual in millionths of the sun's visible hemisphere) and that of the entire group about 820. The new group which had formed *n.p.* the chief spot was a straight stream of the ordinary type, and of total area on October 3 of about 200.

The principal feature of the chief spot was the striking manner in which the nucleus was cut up by intersecting bridges into three lobes; the nucleus as seen in an inverting telescope, on October 3, strongly resembling in shape the ace of clubs.

The train which had followed the chief spot during its former appearance was represented during its second only by a few small scattered spots without any definite arrangement. The entire group, however, still extended over some 11° of solar longitude.

Bad weather prevented observation of the spot at Greenwich during the greater part of its second course. The chief spot was on the central meridian on the morning of October 6, and it was last seen, close to the west limb and much reduced in size, on October 12. It came a third time into view at the east limb on October 27; a small single spot with area 70.

No magnetic disturbance accompanied its second passage across the central meridian on October 6.

Another great group, of area only inferior to that of the great September outburst, appeared at the east limb on October 22. It formed a broad connected stream of spots, showing much beauty

of detail. Its length on October 24 was 11° , its breadth nearly 5° , and its area about 1200. It passed the central meridian about 2^h P.M. on October 28; and a single wave, of about 20' amplitude in the trace of the declination magnet, followed between 11^h and 12^h P.M.—E. W. M.]

Sun-spot Radiation.

GENTLEMEN,—

In connection with Mr. Wilson's interesting letter on the recent sun-spot printed in your last number, I would like again to call attention to the very marked difference which appears to exist between the relative blackness of a sun-spot when measured by thermal methods and the blackness as observed visually.

I am not aware that any accurate measures of spot darkness have been made photometrically, but some years ago I attempted some rough estimates by means of rotating sectors placed in front of the slit of a spectroscope, producing in this way an artificial dark band in the spectrum of the photosphere which I compared directly with the dark band given by a spot.

I found that it was necessary to reduce the photospheric light at least twenty times to produce a band in the spectrum as dark as that of a well-defined spot-nucleus; and a reduction of about four times was required to match the penumbra. That was in the green and yellow region of the spectrum. Towards the violet the spot-band seemed darker still.

Now the thermal measures obtained by Mr. Wilson in the case of the recent large spot give one-fifth ($\cdot 209$) as the smallest value of the ratio $\frac{\text{umbra}}{\text{photosphere}}$, whilst the mean of the values obtained on the three dates given by him is about one-fourth. That is to say, to the radio-micrometer the umbra of this spot was about as dark as the *penumbra* usually appears to the eye, if my estimates are correct.

Why is the spot so much less dark thermally than visually? The rays which have the greatest heating effect in sunlight are also those to which the eye is most sensitive, consequently one would expect the two methods of measuring the relative darkness to be in substantial agreement.

The fact that they are not so seems to me to be of especial importance. It implies that in some invisible region of the spot-spectrum the radiation is much more intense than it is in the visible region. Possibly in the infra-red the dark spot band may even be *reversed*, and could we see the spot by these radiations alone it might appear *brighter* than the photosphere.

It would be of great interest to determine where in the spot-spectrum the radiation is greatest or the relative darkness least. It seems probable that it is in the infra-red, because in the visible

spectrum the spot-band is darker towards the more refrangible end.

Yours faithfully,

Kenley, Surrey, 1898, Oct. 7.

J. EVERSHED.

P.S.—I understand that Mr. Wilson employs two mirrors and an enlarging-lens to form an image of the sun-spot on the receiving surface of the radio-micrometer. Is it possible that the imperfect achromatism of the lens for the infra-red rays, combined with the diffusiveness to which mirrors are liable, accounts for the relatively high readings given? It does not seem likely that this will account for the whole difference between thermal and eye estimates of the umbral radiation, but it would be well to clear up the point.—J. E.

Dark Spots on Jupiter.

GENTLEMEN,—

The subjoined lists are my observed longitudes, System II., of the dark spots A and C, situated on the north equatorial zone of Jupiter during the past apposition:—

Spot A.		Spot A (cont.).		Spot C.	
	λ .		λ .		λ .
1898.		1898.		1898.	
March 6...	123°2	May 19...	112°4	March 2...	316°0
13...	117°3	29...	111°1	12...	311°2
23...	114°9	June 5...	109°9	24...	304°5
25...	118°5	7...	108°5	April 22...	297°5
30...	121°9	17...	97°4	May 13...	288°3
April 2...	119°1	July 4...	96°6	18...	286°5
4...	119°0			30...	284°2
16...	110°7			July 10...	268°7

Remarks on the Dark Spot A.

- 1898 March 25... Dark narrow streak with a faint diffused shading all round; the *p.* end had a faint extension curving southwards, and joining the N. edge of the north equatorial belt.
- 30... This streak was seen from 9 hours; distinct with hazy border next the north equatorial band; no visible extension entering the belt.
- April 2... Dark well-defined streak, the *p.* end pointed and tended to merge in a slanting direction into the north equatorial belt; round the whole of this streak was a diffused shading, which followed the slant of the streak, and joined the north equatorial belt at the *p.* end.

On comparing the letters published in the May and September numbers of the 'Observatory,' it will be noticed that the longitudes of A during March and April are considerably less than that given by Mr. Denning. The only conclusion I can suggest regarding this discrepancy is that the preceding portion of this spot is the darkest part, and hence situated in the above longitudes.

It is as well to add that no tables of predicted central meridian transits were ever prepared, and that the identity of the spots under observation was not known until reduction afterwards. In this way I secured 234 C.M. transits of 50 spots during the last apposition of Jupiter.

I shall be glad to know if any observer can throw some light on the matter, and it is with this object that the longitudes are inserted.

Instrument used, 5-inch refractor by Wray, powers 150 to 250 diameters.

I am, Gentlemen,

Yours faithfully,

HENRY MACÉWEN.

10 Ethel Terrace,
Mount Florida, Glasgow,
1898 October 8.

Wilhelm von Biela.

GENTLEMEN,—

As we shall next month be expecting a fine display of the meteors connected with Biela's Comet, a few particulars respecting Biela himself may be of interest. Wilhelm von Biela was born on March 19, 1782, at Rosslau, near Stolpe-am-Harz, and entered the Austrian army, in which he became a captain and served several campaigns in the war against Napoleon. He died at Venice on February 18, 1856. His discovery of the famous comet of 1826, called Biela's Periodical Comet, as its periodicity was then detected, is well known; also that it had been first discovered by Montaigne in 1772. Perhaps I may be allowed to refer to my history of this comet (which, after separating into two and returning double in 1852, has not been since seen, unless the body observed by Pogson in 1872 was a portion of it) in the 'Intellectual Observer' for April 1867 (vol. xi. p. 208).

Biela discovered two other comets (one before, the other after, that to which he owes his fame), but was in both cases anticipated. The first of these was detected by him on the 30th of December, 1823 (Ast. Nach. No. 48, vol. ii. col. 455), but it had been observed several days before in Paris, and seen earlier still in Switzerland; it is difficult to say by whom first, as it was visible to the naked eye before being observed by astronomers. It had passed its perihelion on December 9, and was the only comet of that year. The other comet alluded to was the only one seen in 1831, and reckons as 1830 II. because it passed its perihelion on the 28th of December in that year. It was discovered by von Biela on the 14th of January, 1831 (Ast. Nach. No. 192, vol. viii. col. 475), but he had been anticipated by William Herapath, who noticed it at Cranford on the 7th of the same month. This comet also was for a time visible to the naked eye.

Biela was the author of several astronomical papers and of a separate publication entitled 'Die zweite grosse Weltenkraft, nebst Ideen über einige Geheimnisse der physischen Astronomie,

oder Andeutungen zu einer Theorie der Tangentialkraft,' which was published at Prague in 1836. In the preface to this little work (which contains 144 pages) he remarks that though it is the fruit of several years of labour, it may be perused in half an hour, a proposition to which we must demur. He considers himself to have detected a relation between the periods of revolution of satellites and the times of rotation of their primaries, an idea which first occurred to him when contemplating Jupiter and his satellites during a visit to the observatory at Naples in 1826, then provided with a new 9-foot refractor by Fraunhofer. By this relation and the indications afforded of what he calls the tangential force, he ventures to determine the time of rotation of the planet Uranus, which he makes 22 hours $8\frac{1}{2}$ minutes; but it should be mentioned that he accepts all the six satellites of that planet and their periods as announced by W. Herschel, though we know now that four of these have no existence. Our own Moon he contends has no axial rotation, a proposition to which he says he met with much opposition in conversation, but it would doubtless have been very agreeable to a late venerable Fellow of the R. A. S.

Yours faithfully,

W. T. LYNN.

Blackheath, 1898, Oct. 1.

New Astronomical Terminology.

GENTLEMEN,—

Appropriate terminology in science is something more than a simple convenience; it has a defining function, and even a kind of propulsive power. So that we may welcome as a real acquisition the word "*nebulum*," proposed by Sir William Huggins, and adopted by Sir William Crookes in his Presidential Address at Bristol, to designate the exotic *world-stuff* originating the chief nebular ray at λ 5007. Originating too, without doubt, its companion at λ 4959, since they appear inseparable and of sensibly constant relative brightness. This cannot be said of any other line emitted by the *nebulæ*; and accordingly assured knowledge of the spectrum of "*nebulum*" begins and ends—for the present—with this pair in the green.

In another department of astrophysics, the want of a name, although not of long standing, begins to be urgent. Two years ago Professor Pickering discovered, in the spectrum of the lucid star ζ Puppis, a new series of hydrogen-lines, which has proved to be strongly characteristic of the Wolf-Rayet stellar type. An expression by which it could be distinguished, unmistakably, and without descriptive circumlocution, from the classic series photographed by Sir William Huggins in the "*white stars*," is certainly a desideratum. A simple and direct way of meeting it would be to call one the "*Pickering*," its associate the "*Huggins series of hydrogen*." These names merely commemorate historical facts; they are strictly "*non-committal*"; whereas the implication of any

hypothesis as to the relations of series might, at the present stage of research, prove misplaced and misleading.

Yours faithfully,
AGNES M. CLERKE.

1898, Oct. 19.

What causes the Gegenschein?

GENTLEMEN,—

As the letter of Mr. T. W. Backhouse on p. 380 of the current (October) number of 'The Observatory' tends to confirm an hypothesis which occurred to me some time ago as a possible explanation of the zodiacal counter glow, I am induced to give it here.

If a black spot of sensible diameter be made upon a sheet of white paper, and be looked at steadily for some seconds in a diffused light, the paper assumes a slightly greyish tint, while the spot becomes surrounded by a bright aureole, like a miniature solar eclipse. If, then, the shadow of the Earth be projected upon the comparatively bright background of the zodiacal band (assuming that the matter of which the latter is composed is disposed somewhat after the manner I have indicated on p. 377 of my paper in the 'Monthly Notices' to which Mr. Backhouse has referred), it is possible that although the Earth's shadow may not itself be visible, it may cause sufficient contrast to make the zodiacal band around it appear brighter than elsewhere. The brighter the band the greater would be the contrast, and therefore the counter glow would appear more distinctly; and Mr. Backhouse states that this is usually the case. If the plane of the zodiacal light be inclined to the ecliptic, the counter glow would appear most distinctly at its nodes, for then the Earth's shadow would be projected upon the centre of the band, which is its brightest part; and in his 'New Astronomy' Professor Todd states that the gegenschein is best seen in Sagittarius and Pisces, while Mr. Backhouse has (according to Chambers's 'Handbook,' 4th ed. vol. i. p. 147) placed the longitude of the ascending node within 5° or 10° of the latter constellation. If the band opposite the Sun lay much above or below the ecliptic, the counter glow would not then be seen.

Could a slightly darker centre be seen in the counter glow exactly opposite the Sun, it would be very strong corroboration of this hypothesis; and obviously, if the diameter of this darker centre could be estimated, we should know very approximately the distance at this point of the matter of which the visible band is composed.

With regard to the supposition of Mr. Backhouse that the zodiacal light may not be due to reflection, Mr. Chambers states in his 'Handbook' that the late Mr. A. C. Ranyard concluded, after having examined the light with a polariscope, that it was reflected; and reflection seems to account very satisfactorily for most of the phenomena which the light exhibits. I am not prejudiced, how-

ever; and after the revelations of Mr. Crommelin in the current number of your magazine regarding the new planet DQ, one may perhaps be excused for feeling disposed to believe almost anything!

I am, Gentlemen,

Yours very sincerely,

WM. ANDERSON.

Funchal, Madeira,
1898 October 14.

OBSERVATORIES.

ROYAL OBSERVATORY, CAPE OF GOOD HOPE.—Dr. Gill's report for the year 1897 opens with a short account of the visit of Mr. McClean to the Cape, and of the state of things as to the McClean Telescope on 1898 January 12. The Observatory was completed as far as was then possible, all the heavy parts of the mounting not having arrived. The rising floor and its hydraulic machinery were erected and in working order. The lower part of the pier was in position, and the rest of the instrument was expected to be dispatched from Dublin shortly.

The meridian work done during the year 1897 consisted of 9371 observations of right ascension and 8743 of zenith distance, which numbers do not include observations made for adjustment of the instrument. The work now in hand is the observation of stars to be used as standard for the Astrographic Catalogue; it is expected that the observations of all of these will be completed by the end of 1899, and then the observers will be at liberty to take up some fundamental meridian work with the new transit-circle, a contract for which has been placed with Messrs. Troughton and Simms.

With the equatorials 152 separate phenomena of occultations of stars by the Moon were observed. Mr. Finlay observed Perrine's Comet I. 1897 on eight nights. Mr. Innes has done a great deal of work in observing stars to detect variability or to verify the reality of stars given in some catalogues of precision*.

Plans have been made for future systematic heliometer observation of all oppositions of the major exterior planets, and work has been begun by two of the younger observers, who made during the year observations of the relative positions of pairs of stars which form part of the triangulation required for the oppositions

* In connection with this work Dr. Gill gives in detail the facts as to the discovery of the large proper motion of Cordoba Zone V. 243, which we reported on p. 106 of our February number. It seems that Prof. Kapteyn, in co-operation with whom Mr. Innes is working, did not find this star on the Cape Durchmusterung plates, and told this to Mr. Innes, who looked for it in the telescope. He also did not find a star in the Cordoba place, but found one about 15 sec. distant in R.A., and suggested that this was the star, and that it has a large proper motion. Prof. Kapteyn again examined the Durchmusterung plates, and found the star in a position which corroborates the proper motion hypothesis. The *kudos* therefore seems to belong to Mr. Innes. We are glad to make this statement, as our note of February last might give a wrong impression.

of Uranus in 1898, 1899, 1900, Saturn in 1898, and Jupiter in 1900. Dr. Gill asks for the co-operation of other astronomers who will make meridian observations of these stars.

With the astrographic telescope 139 plates were taken in all: for about six months of the year this work was suspended on the instrument used by Mr. McClean for the research which was described in our April number. The analysis of this number shows that 72 plates have been added to the Chart series, and 24 duplicate catalogue-plates have been taken. Very little measuring of the plates has been done, but a new measuring-instrument has been received from Messrs. Repsold, about which Dr. Gill remarks, with charming optimism, that it "promises to give even greater rapidity of work than Prof. Turner's method, without sacrifice of the accuracy obtained with the older form of the filar micrometer." Dr. Gill intends to publish a description of the instrument in the 'Monthly Notices,' which may be thought to be a more fitting place for the above-quoted remark than the pages of an official report.

A volume of meridian observations was published during the year, but we note with some regret that the Cape meridian observations of the Sun, Venus, and Mercury, made during the years 1884-92, have not yet been prepared for press. Surely these interesting observations should be put at the early disposal of astronomers, even at the sacrifice of some more showy work. The heliometer observations for parallax of the principal southern stars have been reduced, and the results are given in the Report.

The Government of the British South Africa Company has sanctioned a geodetic survey of Rhodesia, and placed the direction in the hands of H.M. Astronomer.

THESE brief reports of the work done at various Continental Observatories during the year 1897 have been abstracted from the 'Vierteljahrsschrift der Astronomischen Gesellschaft,' vol. 33, pt. ii.

BAMBERG. *Ernst Hartwig.*—With the heliometer measures were made of the diameters of the Sun and Venus, and a good series of positions of Mösting A was obtained. The refractor was used for observations of variable stars including Mira Ceti, β Lyræ, δ Cephei, η Aquilæ, SU Cygni, and U Vulpeculæ; but a more extensive series of observations of variables was made with the Merz refractor.

BASEL. *Riggenbach.*—The geodetic work begun in 1893 was ended in this year.

BERLIN. *W. Foerster.*—The transit circle has been in full swing. From the ordinary working catalogue Herr Battermann has made about 1000 observations, and the determination of the places of some 500 stars occulted by the Moon has been begun. Prof. Knorre has employed the 9-inch refractor in observing minor

planets and comets, and has made about 160 measures of double stars with the double-image micrometer.

BONN. *F. Küstner*.—5302 complete observations have been made with the Repsold Meridian Circle, and much time has been spent in researches on proper motions.

DÜSSELDORF. *R. Luther*.—As in previous years, great attention was paid to minor planets. Since 1847 as many as 2071 observations of 208 planets have been secured.

GENÈVE. *R. Gautier*.—The Plantamour equatorial was in use by M. Kammermann for observations of planets, nebulae, and clusters. Several good photographs of the Moon have also been taken. The great work of this institution is the rating of chronometers, analogous to the work done at Kew. As many as 578 watches passed through the test during last year.

GÖTTINGEN. *Wilhelm Schur*.—Measures of equatorial and polar diameters of the Sun have been continued as in previous years. Altogether 488 determinations have been obtained on 122 days. Distances of Jupiter from neighbouring stars at opposition, also of Saturn. Observations for parallax of 61 Cygni and of Polaris. The great heliometer was employed by Dr. Ambronn for measuring the diameters of Venus and Sun; and the small heliometer for observations of Struve's wide pairs.

HAMBURG. *G. Rümker*.—A large number of observations of comets and small planets. Chronometer work. Time-signals.

JENA (University). *Otto Knopf*.—Positions of comets and small planets. These are published in the 'Astronomische Nachrichten.' Meteorology.

JENA. *W. Winkler*.—Observations of comet Perrine (1896). Occultations of stars by the Moon. Satellites of Jupiter. The 4-inch refractor was devoted to the study of the Sun's surface, which was examined on 226 days.

KALOCSA. *J. Fényi*.—The Sun's limb was completely examined on 164 days and partially on 20 days. There were only 15 prominences over 100" in height.

KIEL. *Paul Harzer*.—Time Service. Meteorology.

KIEL. *H. Kreutz*.—Die Centralstelle für Astronomische Telegramme. Publication of the 'Astronomische Nachrichten.'

KÖNIGSBERG. *Hermann Struve*.—The meridian work included observations of the Sun, large planets, and Burnham stars. Dr. Cohn, with the heliometer, made measures for parallax on β Cygni, 6 Cygni, Σ 2398, χ Delphini, θ Perseus. The observatory has been enriched by a 13-inch Jena glass refractor.

LEIPZIG. *H. Bruns*.—The printing of the zone and parallax observations is in a forward state. Dr. Hayn is employed in triangulation of the Moon.

[To be continued.]

PUBLICATIONS.

GENERAL ASTRONOMY.*—In our issue of 1889, April, we had the pleasure of introducing to our readers the first edition of Young's 'General Astronomy.' The dilapidated condition of our volume of that edition was a continual reminder that, in more respects than one, a second edition was necessary. The progress made in almost every branch of astronomy during the interval began to give Young's book a somewhat antiquated tone, and we herald a second issue with much satisfaction. Perhaps the condition of our volume is the best possible testimony of esteem and undeniable evidence that it has been used as a "directory of information." We are glad to see that the method of deducing the constant 206265 (page 6) is correctly given as $\left(\frac{360}{2\pi}\right)^\circ$ and not $\left(\frac{2\pi}{360}\right)^\circ$ as in the first edition. Also on page 20 there is a reference to the use of globes, which we are glad to note as the teaching of this practical subject seems to have fallen out. Naturally the "Variation of Latitude" receives more space, but we would have been better pleased to see the diagram showing the motion of the pole attached to its proper paragraph; instead of as a rider to question 7 at the end of Chapter IV. By the way, the insertion of the questions at the end of the chapters is a good thing, especially as these questions appear to have been framed with great care. We pass chapter after chapter of such excellence that really one cannot but admire the thorough way in which Prof. Young has absorbed all the latest facts and given them out in short, concise paragraphs. We stop, however, at Chapter XV., which would, in a second rate book, be admirable; but here we may consider it a little loose: that is, the figures given for certain dimensions are rough, a statement here and there is vague and perhaps misleading. For instance, on page 347, in speaking of the minor planets, we have: "all of them united would not make a planet one-fourth the mass of the Earth"; which is quite true, but it would read better as $\frac{1}{40}$ th. Again in speaking of the transits of Mercury (p. 351), it would be better to put in the sequence 7, 13, 13, 13, 7 years, as the following numbers would then be more clear; also for the May intervals he implies that they may fail at 13 years, but does not mention the interval which would elapse then. They generally come alternately, 13 and 33. Then taking this chapter in connection with its tabular synopsis on pp. 603-605, there is not only the roughness in numbers, but a real ground for complaint. When such an excellent series of measures of the dimensions of the planets and satellites, as those made by Prof. Barnard with the Lick telescope, are available, there is no excuse for using rough measures

* 'A Text-Book of General Astronomy.' C. Young, LL.D. Ginn & Co., Boston, U.S.A., 1898.

and measures of satellites made with a 7-inch telescope. For instance :

	Equatorial diameter.		Polar diameter.	
	Barnard.	Young.	Barnard.	Young.
Jupiter.....	90,190	88,200	84,570	83,000.
Saturn	76,470	75,000	69,780	68,000.
Uranus (mean)	34,900	32,000		
Neptune (mean)	32,900	35,000		

In the case of the satellites of Jupiter, it is true, Barnard's values differ but little from Engelmann's except for J.iv., where it amounts to 13 per cent.

On the other hand the chapter on comets is beyond praise, and contains, we believe, the fullest account of Bredichin's work on comets' tails to be found in our language. The "capture theory" is treated of well, and brings out prominently a fact often lost sight of, viz. :—that Jupiter may turn an elliptic orbit into a parabolic as well as the reverse. Callendreau's work on successive subdivision of comets is also noticed. The chapter on double and multiple stars and its tabular table (p. 608) might be improved, and we did hope to see the picture of the system ϵ and 5 Lyræ corrected (p. 541), and the cut on p. 547 might be more up to date. Our real trouble is, however, with the remark on p. 546 : "Table V. in the appendix gives the elements of twenty-two of the best known orbits," for on turning to this table we find :—

σ Coronæ Bor., with period.....	370°0'±25 years.
36 Andromedæ „ „	349°1' „
α Geminorum „ „	997 „

Now if 22 only are selected, they ought to be beyond reproach, i. e. the periods ought to be well established and recently computed. Again, if we allow β 883 a place in the list, who would recognize it under the title Ll. 9091? Now, having relieved ourselves of a critic's duty of finding faults, let us have the more pleasing turn at congratulating Prof. Young on producing a book of so high an excellence as to call forth the above complaints which would, in any other work, have been unnoticed. Those of our readers who do not possess a copy must remedy the defect at once, as in it they will find in concise language the latest developments of the science, and also the means of properly understanding those parts not before included in their reading. To the student it is invaluable.

LOWELL'S OBSERVATIONS OF THE PLANET MERCURY*.—At various times during the past two years we have had glimpses of the work being done, by the Lowell observers, on the planets Mercury and Venus. We are now favoured with the complete results of the researches on Mercury, arranged in an admirably

* 'Memoirs of the American Academy of Arts and Sciences,' vol. xii. no. iv., June 1898.

lucid and concise form, in vol. xii. no. iv. of the 'Memoirs of the American Academy of Arts and Sciences.'

The work began at Flagstaff, Arizona, in the autumn of 1896, and was completed in Mexico. The object in view originally planned was to obtain, with the aid of the 24-inch refractor, the rotation period of the planet; but owing to the distinctness and permanence of the surface-markings, this end became submerged in a more extensive scheme, the study of the surface structure. In describing the methods Mr. Lowell throws out some remarks interesting to those who follow the periodic discussion of *Large v. Small Telescopes*. He says that the results obtained were due not to large aperture and keenness of vision—a small aperture being at times better than a large one, and with fairly normal eyes there is practically no such thing as superior keenness of vision—not keenness of sight, but keenness of brain, distinguishes the good from the bad observer. Due neither to aperture nor eye, but to the air of the observatory site, backed by persistence in the observer—the air must be steady rather than clear, the observer must study his subject. Here Mr. Lowell gives a useful hint—"the best time to study him is when planetary almanacs state, 'Mercury invisible during the month.'"

As regards magnifying-powers Mr. Lowell finds that eyepieces ranging from 135 to 170 are best on the 24-inch; from 75 to 135 on the 6-inch: the device of diaphragming the emergent pencil being in favour with Mr. Douglass.

The measurements were made with a filar micrometer, the double-image being found unsuitable and the measures less reliable. Altogether 311 drawings and 12 sketches were made of the planet's disc. The markings on these proved permanent and distinct, and as the intervals between successive drawings range from 0.6 of an hour to several days, there is ample material to determine the rotation-period, which Mr. Lowell puts down as 87.969 days. He further says that there is evidence that it has so rotated from the time it was plastic. The rotation is approximately perpendicular to the plane of its orbit. The markings, Mr. Lowell finds are unlike those of any other planet, being long, narrow, and dark; irregular in width and appearing at times like a row of dots; very symmetrically placed and darkest at the intersections. From a study of these he concludes: (1) that nothing veils the planet in the way of clouds; (2) that it holds no appreciable atmospheric envelope; (3) that it has no polar snows; (4) that it supports no vegetation; (5) that no change takes place upon it; (6) and that, in short, it is a dead world.

The cause of the markings can be none other than the heat received from the Sun. The continuous hiding of one hemisphere from the Sun's rays would cause a greater contraction in it than in the other, and the unequal cooling of one side would result in cracks—cracks which we now see as markings. The visible por-

tion, owing to libration, comprises about five-eighths of the entire surface.

The measures of diameter show that the hitherto received values are too small :

Polar diameter uncorrected for irradiation	7.80
Polar diameter corrected for irradiation	7.54

equivalent to about 3400 miles. Mr. Lowell gives a number of drawings which show the markings in a wonderful manner.

A FEW generations ago a subject that took an important place in a school curriculum was the "use of the globes." It was taught, if we remember aright, by Mr. Squeers and other famous teachers, but in modern days it appears to be among the lost arts, its place being taken by physiography or some subject with a nice title. This seems a pity, for a globe is an instructive article; in the hands of a competent teacher there is much to be learned from one, and problems with globes call for considerable ingenuity. We are led to make these remarks by the fact that Messrs. George Philip & Son have sent us for inspection a pair of globes they are now selling for a small sum, which are equally suitable for a schoolmaster or an astronomer. The globes, of six inches diameter, turn on an axis mounted on a wooden stand, but they have no horizon nor meridian. On the celestial globe the stars are clearly marked in white on a blue ground, and in our opinion this globe supplies a convenient help to learning the heavens. The terrestrial sphere is no less distinct; and if used for no other purposes, the pair form not unsightly ornaments for a library or study.

ECLIPSES OF THE MOON IN INDIA *.—This work is a continuation of 'The Indian Calendar' by the same author, which was reviewed in these columns in Aug. 1896. Its object is to facilitate the identification of Indian dates by means of eclipses of the Moon. All the eclipses of the Moon contained in Oppolzer's Canon between the years 300 and 1900 A.D. are tabulated here, the dates being given both according to the Western and the Hindu reckoning. The times have been transferred from the Greenwich meridian to that of Lanka ($75^{\circ} 46'$ East of Greenwich), and the day is made to begin at 6 A.M. instead of at noon.

The work also discusses the method of testing the visibility of any eclipse as seen from any part of India. Auxiliary tables contain :—

- (i.) The equation of time for every fifth day and every 200 years, intermediate years being found with sufficient accuracy by interpolation.

* 'Eclipses of the Moon in India.' By Robert Sewell, late of H.M.I.O.S., F.R.G.S., &c. Swan, Sonnenschein, & Co., 1898.

- (ii.) The apparent time of sunset for all declinations of the Sun, and from latitude 0° to 39° .
- (iii.) The circumstances of the eclipses from 1768 onwards as given in the 'Nautical Almanac,' so that for this period either the 'Nautical Almanac' or Oppolzer's Canon may be used as preferred.

Some additions to the 'Indian Calendar' are now given to explain native systems of denoting dates by words, letters, and syllables, also a table for finding the commencement of the lunar-solar year from 300 to 1100 A.D.

This book, in conjunction with 'The Indian Calendar,' will obviously be of immense use to all who are engaged in the work of identifying Indian dates, which seems to have been a matter of great difficulty until thus systematically treated.

NOTES.

COMET NOTES.—A bright comet (*i* 1898) was discovered by Brooks at Geneva (U.S.) on Oct. 20. The following elements are by Prof. Hussey from observations on Oct. 21, 23, 25 :—

T	1898 Nov. 23.14 G.M.T.
ω	$123^{\circ} 22'$
Ω	96 10
<i>i</i>	140 19
$\log q$	9.8787

Ephemeris for Greenwich midnight.

R.A.				N. Dec.				R.A.				N. Dec.			
h m s				$^{\circ} ' "$				h m s				$^{\circ} ' "$			
Oct. 31 ..	17	9	8	30	11			Nov. 8 ..	17	44	52	12	41		
Nov. 4 ..	17	30	28	20	30			12 ..	17	54	30	6	50		

The orbit closely resembles that of Comet 1881 IV.; identity, however, is not possible.

The following new elements of Comet *h* 1898 (Perrine-Chofardet) are by Berberich (Ast. Nach. 3524; observations on Sept. 15, 21, 28) and by Perrine (Ast. Journ. 446; observations on Sept. 12, 17, 22) respectively :—

Berberich's Elements.				Perrine's Elements.			
T	1898 Oct. 20.5779	Berlin M.T.		Oct. 20.5348	G.M.T.		
ω	$162^{\circ} 20' 25''$	} 1898.0.		$162^{\circ} 26' 8''$	} 1898.0.		
Ω	34 53 32			34 55 38			
<i>i</i>	28 51 1			28 51 27			
$\log q$..	9.62375			9.62269			

Ephemeris for Berlin Midnight (Ast. Nach. 3524).

R.A.					S. Dec.					R.A.					S. Dec.				
h m s					° ' "					h m s					° ' "				
Nov. 11	..	16	6	15	31	53				Dec. 5	....	18	40	36	40	2			
15	..	16	33	53	34	28				19	....	19	2	11	40	5			
19	..	17	1	8	36	30				13	....	19	22	19	39	55			
23	..	17	27	41	38	0				17	....	19	41	3	39	36			
27	..	17	53	14	39	3				21	....	19	58	23	39	12			
Dec. 1	..	18	17	36	39	42				25	....	20	14	19	38	47			

Brightness 2.1 on Nov. 11, 0.2 on Dec. 25.

At the end of September the comet was very bright and visible to the naked eye.

On Oct. 28 it passes within 6 millions of miles of Mercury.

Ast. Nach. 3524 contains a search ephemeris of Denning's Comet, 1881 V., which should pass perihelion about 1899 Feb. 10:—

R.A.					S. Dec.					R.A.					S. Dec.				
h m					° ' "					h m					° ' "				
Nov. 2	....	17	6		25	42				Nov. 26	....	18	17		26	45			
14	....	17	39		26	27													

Probable error some 16^m in R.A., 1° in Dec.

Ast. Nach. 3523 contains Mr. Tebbutt's observations of Encke's Comet. The comet was first seen by him on June 11, when it appeared as a round, well-condensed nebula about 30" in diameter. It was again observed on June 12 and 15. But on June 25 the object was invisible in spite of a clear sky. On June 26 and July 10 it could just be observed with great difficulty, but measures for position could not be obtained. This sudden loss of light by the comet is fully confirmed by Mr. John Grigg's observations at Thames, New Zealand. It would seem to have expanded rapidly after passing perihelion, and its proximity to the Earth only rendered it more diffused and increased the difficulty of seeing it.

Numerous observations of Coddington's Comet were made in the Southern Hemisphere in July and August; it was then quite a conspicuous object.

Ast. Nach. 3524 contains the following elements of this comet by Mr. Merfield, from observations on June 15, July 11, Aug. 4:—

T	.....	1898 Sept. 14	1041 G.M.T.
ω	.....	233° 18' 4"	
$\varnothing$	.....	73 59 23	
i	.....	69 54 46	
log q	....	0.23064	

Ast. Journ. 444 contains the following elements of Comet e

1898 (Perrine) by Mr. Perrine; they are deduced from a large number of observations extending from June 14 to Aug. 8:—

T	.....	1898 Aug. 16.1998 G.M.T.
ω	.....	205° 36' 24"
Ω	.....	259 6 12
i	.....	70 1 37
log q	....	9.79695

Ephemeris for Greenwich midnight.

	R.A.			S. Dec.		R.A.			S. Dec.
	h	m	s			h	m	s	
Nov. 1....	14	16	6	45 36	Nov. 13....	14	55	55	46 39
5....	14	30	5	45 59	17....	15	7	48	46 59
9....	14	43	21	46 19	21....	15	19	1	47 23

The brightness on Nov. 1 is half that at discovery.

A. C. D. C.

MINOR PLANET NOTES.—Observations of DQ have been continued, and the errors of Dr. Berberich's ephemeris are as follows:—

Date.	Observed R.A. — computed.	Observed Dec. — computed.
Sept. 8	+ 1.78	— 1.6
16	+ 4.89	— 6.4
22	+ 8.3	— 12
Oct. 8	+ 20.6	— 12 (?)

The following elements have been computed by M. Fayet from observations on Aug. 15, 26, Sept. 7 (*Ast. Nach.* 3524). These elements are probably somewhat more accurate than those of Dr. Berberich, as the interval is 6 days longer, but they are not yet to be regarded as final:—

Epoch	1898 Aug. 15.5 Paris M.T.
M π	221° 25' 0"
Ω	114 32 45
i	302 25 38
ϕ	9 57 35
μ	12 12 14
log a	2018".45
log a	0.163326
Period	1.758 years = 642.2 days.

Perihelion distance 1.148, Aphelion distance 1.764.

According to these elements the planet passes perihelion on 1901 Jan. 22, and the Earth passes the longitude of its perihelion on Jan. 15, so that the next opposition will be a more favourable one according to these elements than according to Berberich's.

The synodic period is equal to 2·31947 years, so that, after 3 synodic periods, oppositions repeat themselves in nearly the same regions of the orbit.

The following is an approximate ephemeris for Berlin midnight :—

	R.A.			S. Dec.		R.A.			S. Dec.
	h	m	s			h	m	s	
Nov. 3....	21	1	14	4 46	Nov. 19....	21	25	29	3 13
11....	21	12	36	4 4	27....	21	39	39	2 14

Magnitude 12·0 on Nov. 13.

Planet DR has been named Hungaria, as was doubtfully announced last month.

This planet has mean distance 1·946, eccentricity 0·074, perihelion distance 1·803, inclination 22° 34' (Ast. Nach. 3525).

A. C. D. C.

PARALLAXES OF SOUTHERN STARS.—The parallax results given in Dr. Gill's report mentioned on page 409 are as follows :—

		Parallax.			Parallax.
β Orionis ..	0·000	$\pm 0·010$	α Gruis	+0·015	$\pm 0·007$
β Centauri ..	+0·046	$\pm 0·017$	Antares	+0·021	$\pm 0·012$
Sirius	+0·370	$\pm 0·0097$	Fomalhaut ..	+0·130	$\pm 0·014$
Canopus....	0·000	$\pm 0·011$			

THE NOVEMBER METEORS.—An important paper, relative to the expected shower of Leonids, was read before the British Astronomical Association on Oct. 26, by Dr. G. Johnstone Stoney. The paper, which is of considerable length, arrived too late for inclusion in our present issue, but we desire to draw the attention of our readers to the following paragraph extracted from it :—

"The Earth is able to deflect the meteors to such an extent that the maximum relative deflection is as much as two-thirds of a degree. It is evident that unless this error is eliminated we can only obtain a rough knowledge of what the radiant is; and the way that I propose that it should be eliminated is by making separate records of the observations in each quarter of an hour. It would then be possible from the position of the apparent radiant and from the position of the Earth to reduce from the apparent to the true radiant. This I believe to be a very important improvement upon the methods which have hitherto been in practice. Of course the radiant cannot be determined, except in a rough way, by eye observations, and every effort ought to be made to obtain it by photography."

Mr. Maunder in commenting on Dr. Stoney's paper pointed out that it would not be necessary to use clock-driven equatorials for photographs of the radiant. Fixed cameras would do perfectly

well, if the exposures were limited to a quarter of an hour each, and the time of the beginning and end of each exposure carefully noted. The time, too, at which any specially bright meteor crossed the part of the sky commanded by the camera should be noted. It was to be hoped that many photographers would take up the work.

A NATIONAL PHYSICAL LABORATORY.—In August 1897 a Committee was appointed to consider the subject of the establishment of an institution under State control for the testing and verification of instruments used for physical investigation, for the formation of standard measures, and for the accurate determination of physical constants and numerical data required in scientific investigation. This Committee have recently issued their Report, the practical proposal in which is that both the buildings and the scope of the work of Kew Observatory should be enlarged. It is proposed that it should still continue to be controlled by a governing body appointed by the Royal Society, but that this body should not consist wholly of Fellows of that Society. The proposal that the permanent Secretary of the Board of Trade should be an *ex officio* member of the governing committee, and that that body should be consulted by the Standard Office and the Electrical Standardising Department of the Board of Trade upon questions that arise from time to time, seem to show that the Committee desire to make the proposed institution available for practical purposes rather than for those of abstract science.

COMET II. 1861. A CORRECTION.—Mr. Lynn asks us to correct a sentence in his letter on this comet, dated Sept. 19. At the top of p. 378 it is stated that, according to Seeling's ephemeris, the comet when nearest the Earth on June 30 was distant from us 0.80 in terms of that of the Sun. That was the distance there assigned for July 30 (Ast. Nach. No. 1319, vol. lv. col. 368). When nearest the Earth, on the morning of June 30, the comet's distance from us was, as determined by Prof. Kreutz (Inaugural-Dissertation, p. 5), only 0.133, or about 12 millions of miles.

COMET II. 1861.—With reference to the subject of the preceding note Mr. W. E. Plummer, Director of the Bidston Observatory, has written to us to point out that there was a later observation than that on March 22 mentioned by Mr. Lynn, for the comet was observed at Poulkova on 1862 May 2, although the observation was too inaccurate to be brought into any discussion of the orbit. He goes on:—"Perhaps I may be permitted to give here the orbit, which I computed but never published. It is not intended to compete with Dr. Kreutz's definitive work, though having been founded on all the published observations I am disinclined to trust too im-

plicitly to the small probable error which he assigns to the period. In a multitude of observers I did not find wisdom, and the difficulty I experienced in satisfying the pre-perihelion places made in the Southern Hemisphere made me reluctantly drop the calculations. I attributed this difficulty at the time to the erroneous places of the stars of comparison. The date of my calculations was 1872, and for several of the positions I had to trust to Lacaille's Catalogue. I find that I have made several solutions of the equations of condition with varying weights attached to the earlier normal positions, and the orbit with which I felt the least dissatisfied is as follows:—

"Term of Perihelion Passage...	1861 June 11.49873 G.M.T.	
Longitude of Perihelion	249° 4' 8".7	} M. Eq. 1862.0
Longitude of Ax. Node.....	278 58 49 6	
Inclination	85 26 19 0	
Excentricity	0.9848040	
Semixis Major.....	54.11305	
Period of Revolution	398.06 Julian years.	

"Like Dr. Kreutz, I also made some attempt to trace the return back in past history, but without much success on my part. Mr. Lynn does not say how Dr. Kreutz fared. There is a very unfortunate tangle in the description of the comets seen about the middle of the fifteenth century. Whether two comets or one were seen in 1454, and whether the accounts should be transferred to 1456, is just a very interesting question of history. I may mention that one of these comets is described as occulting the Moon! Such a record is, I think, unique in the history of modern astronomy."

THOUGH not an astronomer himself, Mr. J. V. Poole may be known to astronomers, since he makes excellent clocks and chronometers for many of them. We happened to see a very laudatory account of a lecture recently given by him, at a suburban literary society, with the title of the "Royal Navy." A subject not without interest at the present time.

FROM AN OXFORD NOTE-BOOK.

IN the August number it was remarked in these Notes that there was some little discrepancy between the observed variation of latitude and the predicted variation—the prediction being that so courageously made by Dr. Chandler some years ago; and the hope was expressed that we might soon hear from headquarters on this interesting point. The hope was well founded. In the number of the 'Astronomical Journal' for October 14 Dr. Chandler compares the observed and predicted motions of the Pole 1890–1898, and determines the revised elements. The little discrepancy above alluded to is duly noticed as follows:—

The only serious departure is in the portions of the curve after the beginning of 1896, after which date the location of the pole of figure by observation is sensibly and systematically behind that of theory, by an amount corresponding to about 15 or 20 days' motion in the orbit.

Otherwise the curves of observation and prediction are nearly identical. Hence a slight though sensible modification of the theory is called for. Dr. Chandler concludes from the facts that the velocity of rotation of the pole in the 14-month period is not uniform, at any rate at present; and, if I understand him rightly, inclines to the belief that the period has changed progressively since 1860, though the progression cannot be carried back beyond that date. It seems as though we are on the threshold of the study of a complex phenomenon, and must prepare for patient and continued observation. The first great step has been made, but there may be many smaller ones to take. I must refer those interested in the details to the original paper (A. J. 446), a thoroughly characteristic member of the series in which Dr. Chandler has developed his theory. Can he not be persuaded to publish this series separately? It is well worth it.

There is also a sequel to another note published in the same number, remarking on a curious brass in Adderbury Church with the date February 30, 1508, on it. Dr. Geelmuyden, of Christiania, has sent me the following most interesting letter under date 1898 October 18:—

According to an Oxford Note in the 'Observatory' for August the owner of the Note-Book has seen this summer an epitaph dated 30th February, which he considers as a mere slip. I have no reason to doubt this consideration; but perhaps it may interest him to know that there is a country where it has happened that the month of February has had 30 days. The country is Sweden, and the year was 1712. I suppose it is the only instance since the days of Numa Pompilius. As you know, the New Style was introduced in some countries, among them Denmark and Norway, in 1700, by leaving out the days of February after the 18th. In Sweden they had also resolved to make a reform; but instead of dropping the whole lot of days at once, they preferred to do so gradually, and as a beginning the year 1700 was made a common year. For some reason or other, however, this scheme was not continued in the following years, the consequence of which was that the dating in Sweden was, for some years, one day ahead of the Old Style and ten days astern of the New. As this could not well go on, they resolved to revert to the Old Style, and this was done in the leap-year 1712 by taking up again the day which had been omitted in 1700; this day was intercalated between February 29 and March 1, and was consequently named February 30. The New Style was introduced in Sweden in 1753, but only for the dating; the computation of Easter and the other movable festivals then introduced was akin to, but not identical with, the so-called Reformed Computation, which was used in Germany for more than 70 years of the last century. As it was not till 1844 that the Gregorian Calendar was adopted in full, it has happened, even in this century, that Easter in Sweden was celebrated at a time differing from that of all other countries.

Now that the 'Daily Chronicle' has exposed M. de Rougemont, or Mr. Grin, it is quite easy to say "I told you so"; and ac-

cordingly I beg to point out how the imposture of this modern Robinson Crusoe might have been detected in the very first number of the 'Wide World Magazine' from astronomical considerations. For the information of those who have not heard of M. de Rougemont, I may say that he claimed to have been wrecked on a desert island just north of Australia—a particularly desert island, only 100 yards by 30 yards, and with no vegetation, where he lived for $2\frac{1}{2}$ years in solitude. His deposition contains the following sentences:—

The great thing was to ward off the dull agony, the killing depression, and manias generally. Fortunately I was of a very active disposition, and as a pastime I took to gymnastics, even as I had at Montreux. I became a most proficient tumbler and acrobat, and could turn two or three somersaults on dashing down from the sloping roof of my hut: besides, I became a splendid high jumper, with and without the pole. Another thing I interested myself in was the construction of a sun-dial. I spent many hours devising some means whereby I could fashion a reliable clock, and at last I worked out the principle of the sun-dial on the sand. I fixed a long stick perfectly upright in the ground, and then marked off certain spaces round it by means of pegs and pearl shells. I calculated the hours according to the length of the shadows cast by the Sun. I always retired at sunset and rose at sunrise.

There is a picture of the castaway and his vertical stick, marking out a beautiful azimuthal circle with pearl shells. Of course the illustrator may be responsible for the azimuthal circle, but the vertical stick is declared by the text to be the author's own. A more hopeless instrument to call a sun-dial in the tropics it would be difficult to conceive. The shadows would fall in all sorts of azimuths according to the time of year. I note, of course, the phrase about determining the hours according to the *length* of the shadows, but this would be more complex still.

It is perhaps a pardonable weakness to lean towards some notice of contemporary events here. And now that our thoughts are so much in the Soudan I am reminded that I have in a scrap-book a curious cartoon, which shows as much carelessness about elementary astronomical facts as the picture and description mentioned in the last paragraph. It is a cartoon dated October 10, 1896. The shade of Gordon is standing on the walls of Khartoum with his back to us, regarding the tents of the Sirdar's advancing army, shown in the distance, and asking, "Aren't you coming any further, after all?" At the top of the picture, hanging over the tents at an altitude of about 15° , is the Sun. How it gets into the north in Egypt, in October, must be explained by the cartoonist. It would have been almost better to put a rainbow there. And talking of rainbows reminds me of a quaint remark made the other day by an enthusiastic little damsel of six years, who suddenly caught sight of one. "Oh, Granny!" she said, "look what a beautiful sunstroke!" The misnomer is, after all, quite as

appropriate as rainbow: it is only a different view of the same phenomenon.

BUT to return to the Soudan. The following clipping from the the 'Daily Telegraph' of October 22 seems to me worthy of record:—

CHRONOMETER'S WANDERINGS IN THE SOUDAN.

Upon reoccupying Omdurman, after the defeat of the Dervish forces under the Khalifa, the 17th Soudanese encamped for the night under the Beit-el-Anana, and in an adjoining house, belonging to the Khalifa, a ship's chronometer, made by Charles Frodsham, London, No. 3533, was found in perfect condition, case, lock, glass, and all being as good as new. The instrument had probably been for years in the Khalifa's possession.

Messrs. Frodsham and Co. write:

"We find by our books that the chronometer referred to was sold to Sir John Fowler in 1871. Sir John was then carrying out some important railway work in Egypt, but we have been unable to trace the subsequent history of the instrument."

SOMETIMES on eclipse expeditions to remote parts of the Earth there has been a certain amount of anxiety lest the natives should misconstrue the presence of the astronomers, and wreak vengeance for the supposed calamities brought by the eclipse on the visitors and their instruments. Thus in the West Indies, in 1886, rumours were spread of the impending destruction of the islands (if not of the world) by a "tidal wave" brought on by the eclipse; so that some slaughtered their pigs and ate them at once, and others drew their money out of the bank and squandered it in riotous living while there was yet time; and we, who were hoping to make observations, were rather afraid of some disturbance at the critical moment. But there was none; the crowd of spectators uttered never a sound. Nor do I remember any occasion on which such fears proved well-founded, perhaps because adequate precautions have usually been taken against their realization. Apparently we should have more chance of excitement in the Isle of Wight. There is a scare just now about a ghost or spring-heeled jack, which brings out crowds every night, some members armed with guns. The neighbourhood is that in which Prof. Milne has been observing earth-tremors, under primitive conditions as regards accommodation, but with conspicuous success. "Some wretch," he writes to me under date October 21, "started the idea that as I observed earthquakes when there are no earthquakes I might be the author of the ghost. Result has been a warning to lock up my instruments and keep a sharp look out, or these enthusiasts may clear out the installation. That small light twinkling through the trees up on the Down side seems likely to result in harm! And this is 19th century civilization." The letter ends with a prayer for rain to cool the ardour of the investigators.

THE OBSERVATORY,

A MONTHLY REVIEW OF ASTRONOMY.

VOL. XXI.

DECEMBER, 1898.

No. 273.

MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

Friday, November 11, 1898.

Sir R. S. BALL, LL.D., F.R.S., *President*, in the Chair.

Secretaries: Prof. H. H. TURNER, M.A., B.Sc., F.R.S., and
H. F. NEWALL, M.A.

THE Minutes of the previous Meeting were read and confirmed.

Mr. Newall. Since the last Meeting 213 presents have been received by the Society. I will call attention, amongst others, to the following:—Prof. Hale has sent some reprints of publications of the Yerkes University Observatory, Chicago; a revised edition of Prof. Young's book, 'General Astronomy,' has lately appeared, and a copy of that has been presented to us. Prof. Chandler has sent us his comparisons of the computed and observed motions of the pole during the period 1890–99. I will call special attention to Mr. McClean's spectra of the Southern Stars, in which he completes the photographic survey of the spectra of stars in both hemispheres. We have also received the fourth volume of the 'Annals of the Cape of Good Hope,' this being the second volume out of three relating to the Photographic Durchmusterung. We never seem to get rid altogether of the total solar eclipse, for here we have a Report from the Indian Survey Department of observations made during the Eclipse in 1898. We have another part of the Photographic Atlas of the Moon from the Paris Observatory, and also a third volume from Prof. Weinecke of his Lunar Atlas. Also a photograph from Mr. Newbegin, taken at a time when there were many unexpected spots on the Sun; and photographs from the Royal Observatory, Greenwich, of sun-spots. I have also to announce that exceedingly valuable presents of books have been received from Mr. Leeson Prince, of Crowborough; among them eight editions of Aratus and three of Manilius, con-

sisting in all of 43 books, which will be a very valuable and a much appreciated addition to the library.

A vote of thanks was accorded to the donors of the presents.

Captain Noble. In connection with Mr. Prince's present, it is not every man who, like him, parts with most valuable and interesting works during his lifetime. A good many men part with them when they have no further use for them—that is, when they are dead. Mr. Prince, in order to advance astronomical science, has given them away in his lifetime, and I think the special thanks of the Society are due to him.

Dr. Johnstone Stoney then read a paper on the approximate ephemeris of the Leonid swarm through which the Earth passed in 1866, and a forecast of the time of the Leonid shower in 1898. He said that in view of the great value which was attached to observations of the Leonid stream in the open sky if they could be secured, and taking into consideration that the conditions would be more favourable in the coming season than hitherto, Dr. Roberts had expressed his intention to make another attempt to photograph this very faint object by careful and long exposures. In order to enable him and other astronomers to make those observations, an ephemeris had been prepared. If the stream could be photographed, it would probably impress itself as a very faint and somewhat broad band crossing the field of view. It was perhaps not quite impossible that the stream, now that it was getting nearer to the Sun and to the Earth, and that the place to look for it was better known, might be seen with an opera-glass where the atmosphere was unusually clear. The cost of the ephemeris, as on former occasions, had been met by a grant from the Royal Society.

Dr. Johnstone Stoney then made a second communication on this subject, relating more especially to the shower expected in the coming week. Dr. Stoney called attention to the circumstance that Gauss's method of determining perturbations, which was that employed by Professor J. C. Adams in his classical investigation into the dynamics of the Leonid stream, only furnishes the average amount of each perturbation, taking one revolution with another. In continuation of this work the actual perturbations during the current revolution have been computed for that part of the stream through which the Earth passed in 1866, assuming the correctness of Adams's elements. This work has been done by members of the staff of the Nautical Almanac, under Dr. Downing's superintendence, and it has brought to light the fact that in consequence of a near approach to Saturn on the outward journey, and a near approach to Jupiter on the inward journey, the shift of the node since 1866 has been very much more than the average.

If the shift of the node had had only its average amount, the Earth would this year intersect Adams's orbit at the epoch 1898 November 14^d 5^h, that is, at 5 o'clock on Monday afternoon; but by employing the actual shift of the node it appears that the Earth

will not reach this orbit till 36 hours later, that is, at 1898 November 15^d 17^h, or 5 o'clock on Wednesday morning.

It is uncertain whether the front of the ortho-stream, that is the dense stream which produces the great showers, has yet reached the Earth's orbit; but if so the part through which the Earth will pass next week is situated a year and a quarter farther forward in the stream than that through which the Earth passed in 1866, which is the part for which the calculations have been made. Meteors so far in front may have been travelling in 1866 along a slightly different orbit to Adams's orbit, and have almost certainly been subjected to sensibly different perturbations to those computed. Hence the allowance to be made this year for perturbations may not be that which has been calculated; but it probably lies between the average amount and the calculated amount, and probably much nearer the latter, so that if there is a great shower this year, which is quite uncertain, it will probably occur on the night between Tuesday and Wednesday.

Mr. Maunder. The point to which Dr. Stoney refers is simply this:—At the meeting of the British Astronomical Association Dr. Stoney mentioned that it was important that observations should be made in periods of $\frac{1}{4}$ hour each. If photographic observations therefore were attempted, the plates should be exposed for a $\frac{1}{4}$ of an hour, and it occurred to me that there were many Members of the Association who might have ordinary cameras, but who would not have equatorially-mounted telescopes or driving-clocks. Under these circumstances it would seem that it would be sufficient if the camera was rigidly fixed and the times of exposing and closing the plates were carefully taken. If the part of the sky to which the camera was pointing was watched, and the time was carefully taken of the fall of any bright meteor which crossed that region, all the elements would be available for reducing the plate afterwards.

Prof. Turner. The plan of Mr. Maunder is an excellent one if some device can be made for fixing the camera. There is no need to fix it by stars if it can be fixed by proper objects. Dr. Stoney referred to perturbations of the swarm in the last revolution, that have been calculated in the Nautical Almanac Office. I should like to ask him if the result arrived at is the same as that given in the 'Astronomische Nachrichten,' No. 3526, by Berberich. The general result seems to be that the swarm will be delayed by 21 hours. I suppose that instead of the swarm coming on Sunday night, as forecasted in Mr. Denning's interesting little book, it will not come until Monday night. I suppose for such enlightenment we must look to the morning papers.

Dr. Stoney. I can answer Prof. Turner's question. Herr Berberich's results confirm, in a satisfactory degree, those arrived at in this country, when we allow for the circumstance that he made his calculations for the orbit of Tempel's Comet, while

ours have been made for the orbit of the Leonids as determined by Adams.

Captain W. Noble. The moral of this is that it would be politic to keep a watch before midnight on Sunday, before midnight on Monday, before midnight on Tuesday, and before midnight on Wednesday.

Dr. Stoney. More correctly on the night between Tuesday and Wednesday, and the watch should be kept up until daylight on Wednesday. There is no use in observing until 10.30 P.M., when the radiant rises, and the shower may come on at any time between that time and the morning.

Capt. Steele. From observations I have made, I believe these meteors have their origin in the Earth's atmosphere.

Mr. Inwards. It would be a very good plan to make a list of observers who would observe, and the hours they would be willing to do so, so that we may be sure there will be some observers observing, otherwise we may have very serious gaps.

The President then read a paper giving an account of the new photographic telescope at the Cambridge University Observatory. The general design was largely due to the kind suggestions of Dr. Common and Prof. Turner. Mr. Newall rendered most valuable assistance. The Cambridge Observatory is also indebted to Dr. Common for both the mirror and the eye-end of the instrument.

Mr. Hinks exhibited photographs of the progress of the building and construction of the telescope, with explanation.

Mr. Newall. I think it may be of interest to say that we have a novel form of object-glass, as well as a new departure in mounting it. As the President has remarked, it is a triple object-glass of $12\frac{1}{2}$ inches, and certainly it is a very great pleasure to see the whiteness of the image of the star which is produced, and also the smallness of it, and I think we have every reason to regard the beginning which Mr. Hinks has described as giving great hope for the subsequent performance of the instrument. We are all greatly indebted to the architect for the extremely conscientious care with which he has worked out every detail.

The President. I am very much obliged to Mr. Hinks for showing these pictures. No one knows better than I do the energy that Mr. Hinks has thrown into the work all through, and every one appreciates it. I would also like to endorse what Mr. Newall has said about the extreme care and kindness which Mr. Atkinson, the architect, has shown in carrying out what was to him, and to us all, a wholly unfamiliar piece of work.

The Astronomer Royal (presenting papers on Planet 433, 1898 DQ, on Brooks' Comet, and on Sun-spots photographed with the Thompson Equatorial). These papers deal with results that have been obtained recently with the Thompson Equatorial, the chief interest being that they show what can be done with a photographic telescope in the way of determining the positions of

planets and comets, and in photographing sun-spots with a large refractor. As Fellows are aware, the Thompson Photographic Equatorial has now been brought into good adjustment, and Sir Howard Grubb has perfected the object-glass, which is corrected for photography, while Dr. Common has furnished an excellent 30-inch mirror, and the combination of those two telescopes—a photographic refractor and reflector—makes a very powerful instrument for astronomical research. The planet DQ is an object of great interest; but when it first appeared we were hardly in a position to deal with it, as we were engaged in testing the telescope, and were hardly prepared, just then, to devote it to direct research. But as soon as we could we set to work on this very interesting planet, and the difficulty we were confronted with was not only that it was very faint—the magnitude as given by Prof. Pickering is 12.7—but that it had a very rapid motion, so we could not expect to get any results by giving a long exposure, as in the case of very faint fixed stars. An attempt to photograph it with the 13-inch astrographic telescope failed, and also one with the 26-inch, through the rapid motion of the object. Therefore, although we might have got a picture with the 26-inch, still it seemed better to try and get a photograph with the reflector, and I feel very glad that we have been successful in photographing this somewhat difficult object, as well as the rapidly moving comet, and in getting very accurate determinations of their positions.

Of the planet DQ we got photographs on several nights with the 30-inch reflector, focal length 11 feet 3 inches. [Photographs thrown on screen.] The definition of the stars is very satisfactory for a reflector with a very large ratio of aperture to focal length, namely $4\frac{1}{2}$ to 1. By the measurement of the images of the planet and of the comet compared with the reference-stars on the plate, fourteen stars in the case of the planet, we have got a degree of accuracy far transcending that of other methods. The residuals in the stars' places, as found independently from four plates, show that even with the reflector, which is admittedly not so well adapted to accurate measurement as the refractor, we can determine the position of the planet within something like a tenth of a second of arc. I think that is an excellent result. This planet is so interesting, and the determination of its orbit is so important, as its near approach to the Earth will give us the means of determining the Sun's distance with great accuracy, that it is of very great importance to make as accurate determinations of its position as possible. As regards the comet, the observations are also very accordant. I would mention that this being a bright comet, and a comet of special interest from its rapid motion, we have made observations with two instruments (the 28-inch refractor and the Sheepshanks equatorial), and have taken the opportunity to compare observations so as to get an idea of the probable error of the determination of the comet's position from comparison stars

with the ordinary methods in use at Greenwich. I think the result is very satisfactory.

We have photographs of the comet, on each of two nights, and the discordance between the two photographs on the first night was 3".6, and on the next night it was only 0".6. I think that shows that photography is capable of giving extremely accurate results in this class of work, and I feel rather comforted in having arranged to attach to the Thompson photographic equatorial, which was originally designed as a refractor, a reflecting telescope, which has proved of such great use in this particular case, as we have been able to take photographs of a rapidly moving comet which presented a good deal of difficulty for a refractor. Lately also we have been devoting the 26-inch telescope to making some trials in photographing sun-spots. Fellows are aware that a very striking sun-spot appeared in September. By attaching the concave magnifier which I used in India to the 26-inch refractor, we obtained some photographs of these spots on the scale of 29 inches to the Sun's diameter, and some of the photographs are very satisfactory. It was necessary to reduce the aperture to 15 inches to enable us to deal with the overpowering light of the Sun. [Screen.] We find we can advantageously magnify up to a scale of 5 feet to the Sun's diameter, or more. I think the state of the Sun now, in relation to the sun-spot minimum which is rapidly approaching, is a matter of very great interest and deserves study. It seems that the normal course of things is not proceeding, and the sun-spots are not diminishing as we should have expected, and the ordinary law is affected by the remarkable outburst we saw in September and in the spring of this year.

Prof. Turner (who now occupied the Chair). I heard with some interest that the attempt to photograph the planet DQ with the Astrogaphic Equatorial had failed, because at Oxford we similarly got no results. It is a matter for great congratulation that the Astronomer Royal has at his command a telescope with which it is possible to do such work as he has brought before us. We have another paper on sun-spots by Mr. Newbegin, and some slides sent by Prof. Barnard, which Mr. Newall will give an account of.

Mr. Newall. In reading the list of presents I ought to have called attention to this very valuable set of slides which Prof. Barnard has sent to us. The photographs were taken, he said, with the 6-inch Willard portrait-lens. Prof. Barnard considered that these slides were a considerable advance upon those with which he has already made us familiar. [Photographs of the Milky Way were shown on the screen.]

A vote of thanks was passed to Prof. Barnard.

Dr. Isaac Roberts. The photographs sent by Prof. Barnard, which have just been shown projected on the screen, must be well known to all present; for the contact positives-on-glass made from

his original negatives have been exhibited during several months in the Library of the Society and are still preserved. They have also been extensively published in various periodicals, and yet they seem to be as little understood, from a scientific point of view, now as they were when first presented.

Speaking for myself I have frequently made very careful examination, and have tried to see in them the merits which Prof. Barnard and the casual examiners of them profess to see, which, in effect, is that the stars in the *Milky Way* are immersed in dense nebulosity, with numerous rifts trending in various directions within it. At the time I first examined the photographs my opinion was that those vast areas of cloud-like matter exhibited upon them were not due to real nebulosity, but to the effects of starlight and atmospheric glare concentrated by a small lens of short focus during many hours exposure to the sky of very sensitive films; but that the star-images, both bright and faint, having their photo-discs overlapping or brought by the lens into close proximity with each other, together with diffraction effects and the atmospheric illumination consequent upon these conditions, caused the glare, and gave it the appearance of extensive nebulosity. Besides these causes, there is also the manipulation in copying the original negatives, which intensifies their misleading effects.

When the photographs were first presented to the Society some of the Fellows jumped at once to the conclusion that these wonderful photographs, as they termed them, revealed astounding possibilities in the domain of cosmical physics, and having committed themselves to these ideas they have not, even yet, brought themselves to consider them judicially upon their merits.

The real nebulosity with which we can deal in the sky is limited, with few exceptions, to relatively small areas, and generally it is not difficult to distinguish it from the large areas of spurious nebulosity which are so extensively shown on these small-scale photographs.

Referring to the assertions so persistently repeated that there are "Nebulosities exterior to the Pleiades," it is disappointing to find that no photographs have been exhibited to the Meeting and no evidence produced tending to prove the correctness of Prof. Barnard's assertions concerning them; instead of which the Meeting is referred to two photographs presented to the Society years ago, and to statements made that two gentlemen in America had confirmed the existence of the nebulosity, but no evidence whatever is presented to show that there is reliable data available, as well as the necessary experience, to enable them to form a competent judgment concerning this investigation, which requires exceptional care and experience in dealing with it.

If the nebulosity really exists why are the proofs not presented? Real nebulosity should, on a photograph, be indisputably recognized by its characteristics when seen by any competent examiner; but in this case repeated assertions are presented, and not a single

reliable photograph has been produced to prove the simple facts that scientific men most desire to know.

I have many times examined the two photographs referred to by Prof. Barnard, and have not succeeded in finding upon them any nebulosity such as he describes. Why all this assertiveness and mystery about a matter so simple as producing photographs which would unquestionably satisfy any one whose object is not merely academical discussion, but a desire to arrive at the knowledge of that which is true by demonstration? I have shown before the Society my photographs upon which the non-existence of nebulosity of a real character could be detected in the region pointed out by Prof. Barnard, though my plates had been exposed during various intervals between one hour and twelve hours respectively; but there is abundant evidence of spurious nebulosity in patches upon some of them, and, in order to make sure of its spurious character, I had carefully compared the original negatives, and also compared positive copies of them made on glass, with the result that the patches shown on any given plate did not coincide in position, extent, or form, with those on the other plates, though there were casual resemblances in parts; whereas real nebulosity, notwithstanding the fact that intervals of many years have elapsed between the epochs when the photographs were taken, always, invariably, and in every detail coincide on all the plates.

I am of opinion that Prof. Barnard has been misled by absence of sufficient reliable data in forming his very strong opinion, "That there can be no doubt whatever" of the existence of the nebulosity to which he refers, the opinion being based upon only one very defective photograph with $10\frac{1}{4}$ hours exposure; and, further, that any opinion which has been formed concerning very faint suspected nebulosity seen upon a film of high sensitiveness after long exposure to the sky is not worth expressing, nor entitled to any credence, until it has been confirmed by one or two other photographs taken of the region with plates of similar character, and with equal exposure, and afterwards been rigorously correlated with each other by using the stellar images both involved in, and in the light places around, the supposed nebulosity, as fiducial points of reference.

The Astronomer Royal. I had very great difficulty in following Dr. Roberts's criticisms of these photographs. The thing which has struck me so much, and which I think will strike all Fellows here, is not the nebulosity, but the remarkable rifts or dark spaces which are shown in the Milky Way, and in those rifts we have an utter absence of nebulosity and an almost complete absence of stars. The few stars that are shown are shown so sharply that I think that fact negatives the idea Dr. Roberts is trying to put forward—that this nebulosity is due to diffused starlight or defects of the lens. If so, why is it not in those rifts, and why is not the diffused starlight shown all over the plate? When I see these

plates with sharply defined rifts and sharply defined spaces, I feel very great difficulty in accepting Dr. Roberts's criticisms.

Dr. Roberts. The rifts appear because of the absence of stars. There are no stars to give light to fill them up, as is the case in the surrounding neighbourhood. That is the cause of the remarkable rifts in the light. The other parts are crowded with stars, which give light to illuminate the atmosphere and so cause apparent nebulosity*.

The Astronomer Royal. My point is clear. If you get these stars very sharply defined without diffused light, it is not fair to say the diffused light comes from the faults of the lens. The point is, in these rifts we have an absence of diffused light and star-images sharply defined. If the stars are sharply defined there they ought to be elsewhere. I must not be understood to say that when nebulosity is shown it may not be due to a very great number of very small stars, but we have evidence here that the so-called nebulosity is not due to defects of the lens.

The following papers were announced and partly read:—

A. A. Rambaut. "Remarks on Dr. Gill's paper in the 'Monthly Notices' for June, 1898."

Rev. J. G. Hagen. "Note on Mr. Pogson's Manuscripts relating to his proposed Atlas of Variable Stars."

A. Stanley Williams. "On the South Temperate Current of Jupiter."

A. Stanley Williams. "Nomenclature of the chief Surface Currents of Jupiter."

David Gill. "On a New Instrument for Measuring Astrophotographic Plates."

David Gill. "On a Method of obtaining perfectly Circular Dots unaffected by phase, and their employment for determining the Pivot Errors of the Cape Transit-Circle."

E. E. Barnard. "On some Photographs of the Moon, Comets, Meteors, and the Milky Way, and on the exterior Nebulosities of the Pleiades."

Royal Observatory, Greenwich. "Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1897, deduced from Photo-

* If there were areas in the sky so large as fifteen degrees in diameter, and covered as densely with bright and faint stars as many smaller ones are, a photograph of such large area, taken with a portrait-lens and an exposure of ten hours, would show on development the whole photo-field covered with apparent nebulous matter, in the midst of which all but the faintest stars would appear. This is caused by starlight and atmospheric glare. But no such large areas are known, for the stars are unevenly distributed and large crowded spaces embrace smaller ones, that have few or no stars upon them; and these vacant areas—reflecting little if any light—give rise to the rifts, tortuous and otherwise, which are seen on photographs in the midst of the crowded star-areas. In this way is produced the appearance of nebulosity which is spurious; it is simply the effect of contrast between light and dark areas.—[Note added later by Dr. Roberts.]

graphs taken at Greenwich, at Dehra Dûn (India), and in Mauritius."

Royal Observatory, Greenwich. "Observations of Planet (433) (1898 DQ) with the 30-in. reflector of the Thompson Equatorial."

Royal Observatory, Greenwich. "Observations of Comet ϵ 1898 (Brooks) made at the Royal Observatory, Greenwich."

G. Johnstone Stoney. "Approximate Ephemeris of the Part of the Leonid Swarm through which the Earth passed in 1866."

A. C. D. Crommelin. "Ephemeris for Physical Observations of Jupiter, 1898-99."

The following gentlemen were elected Fellows of the Society:—

C. G. J. Dolmage, M.A., LL.D., 22 Upper Merrion Street, Dublin.

A. E. Douglas, B.A., Lowell Observatory, Flagstaff, Arizona, U.S.A.

The following Candidates were proposed for election as Fellows of the Society:—

A. R. Hinks, Cambridge Observatory (proposed by Sir R. S. Ball).

C. L. Brook, Harewood Lodge, Meltham, Huddersfield (proposed by Rev. T. H. E. Espin).

Arthur Hands, L.R.C.P., M.R.C.S., Inkerman House, Wednesfield Road, Wolverhampton (proposed by Samuel Fellows).

S. H. Harrison, F.R.G.S., Frederick Road, Edgbaston, Birmingham (proposed by Sir J. B. Stone).

W. R. Warner, Engineer, Cleveland, Ohio, U.S.A. (proposed by W. H. Maw).

THE BRITISH ASTRONOMICAL ASSOCIATION.

THE Annual General Meeting of the Association was held at Sion College on Wednesday, October 26, *Mr. W. H. Wesley*, Vice-President, in the Chair.

A letter was read from the retiring President, *Mr. N. E. Green*, regretting his unavoidable absence, and commending the matter of the proposed observatory to the careful consideration of the Council, and urging that it should not be allowed to become a charge on the ordinary funds of the Association.

The result of the ballot for the new Council was then announced:—*President and Treasurer*, W. H. Maw; *Vice-Presidents*, Arthur Cottam, N. E. Green, Mrs. E. W. Maunder, and W. H. Wesley; *Secretaries*, J. G. Petrie and William Schooling; *Librarian*, F. W. Levander; *other Members of the Council*, Rev. J. M. Bacon, Rev. A. L. Cortie, Dr. Downing, Sir Wm. Huggins, T. Lewis,

Capt. Noble, Sir C. E. Peeke, Bart., Dr. Isaac Roberts, Dr. Johnstone Stoney, and C. Thwaites. The following appointments, made by the Council, were confirmed by the Meeting:—*Editor*, E. W. Maunder. *Directors of the Observing Sections*: *Sun*, Miss Brown; *Moon*, W. Goodacre; *Mercury and Venus*, Henry MacEwen; *Mars*, E. M. Antoniadi; *Jupiter*, A. Cottam; *Saturn*, G. M. Seabroke; *Comets*, A. C. D. Crommelin; *Meteors and Auroræ*, Henry Corder; *Star Colours*, G. F. Chambers; *Variable Stars*, J. E. Gore; *Double Stars*, G. M. Seabroke; *Spectroscopy*, J. Evershed; *Photography*, R. Wilding; *Zodiacal Light*, Capt. P. B. Molesworth.

The Report and Accounts for the past year were taken as read and adopted.

Cordial votes of thanks to the retiring President and the retiring Members of the Council—Miss Clerke, Sir Howard Grubb, Messrs. A. Kennedy, J. Lunt, G. J. Newbegin, Dr. Smart, F. J. Wardale, and Rev. W. R. Waugh—were passed, special reference being made to Mr. Waugh's valuable service as Director of the largest section ever since the Association started. Votes of thanks were also passed to the Auditors and the Scrutineers of the ballot.

The Chairman, after expressing his regret at the absence of the President, proceeded to review the growth and progress of the Association from its foundation eight years ago, pointing out that, in view of its world-wide membership, the title of British had become almost a misnomer. Capt. Noble, the first President, had spoken of a membership of 1000 as a possible ideal. This had been more than realized. The past year, for the first time, showed no advance. If the membership had reached equilibrium it would only imply that they had attained maturity, and they must remember that most fruit was expected from the full-grown tree. The eight volumes of the 'Journal' contained many valuable papers, and the monthly summary of astronomical publications in England and abroad rendered a service to science that had never been so completely performed as by their Association. The valuable work of the sections was shown in the six volumes of 'Memoirs,' besides many shorter reports in the 'Journal.' So far as he knew, this Association stood alone among scientific societies in undertaking section work. It was most important that the sections should be well supported by the Members, as the future success of the Association must largely depend upon the work done by them.

Amateur workers must avoid the mistake of endeavouring to compete with large observatories and great telescopes. They must do what the great institutions were not doing. Photography opened a large field for the amateur worker. Prof. Barnard had shown what might be done on faint and extended nebulae with a very small lantern-lens, and Mr. Lunt and Dr. Sheldon had shown that excellent star photographs could be taken with comparatively

small instruments. In naked-eye work, such as meteoric observations, all experienced and diligent observers were on the same level. Comet-seeking also did not require great instrumental means, and cometary discoveries did not at all necessarily fall to the lot of great observatories or giant telescopes, as Comets Holmes and Gale, as well as many others, sufficiently showed. Variable-star observation, requiring such slight instrumental aid, was pre-eminently the sphere of the amateur, and the comparison and tabulation of the results required to eliminate the personal element made it specially suitable for the co-operative work of their section. Visual observations of the lunar surface had not been superseded by photographs, for admirable as many of these were, it was undeniable that they did not show smaller details than could be seen even with instruments of moderate size. For questions relating to the origin of the lunar formations, and for evidence of possible changes, it was necessary for these smaller details to be most carefully observed and mapped. Colour changes, of course, could be recorded by eye and hand alone.

In conclusion, he would give a few words of warning. Perhaps it was hardly necessary to mention that kind of vanity which had prompted some possessors of small instruments to fancy they could detect everything that has been seen with more powerful ones. A discovery was made with a 24-in. telescope; some one confirmed it with a 12-in.; later on, the possessor of a 6-in. did not want to be outdone, so that it was said that fine markings were seen distinctly with instruments which could not separate them, and spots seen with apertures smaller than could show them. This spirit of unreasonable emulation produced unseemly disputes, threw discredit upon the observer and the body to which he belonged, and upon other observations the most honest and trustworthy. Closely akin to this error was that of representing conclusions of measurement with an absolutely unattainable accuracy. He would say to those who wished to make independent observations, keep free from all theories, that there might be nothing to bias their minds and influence their hands. If they could not avoid forming theories of their own, they must never hesitate to sacrifice their children. Let their spirit ever be expressed by the good old saying:

“Nullius addictus jurare in verbum magistri.”

Mr. Maunder proposed a cordial vote of thanks to *Mr. Wesley* for his address, and remarked that he did not think they could easily over-estimate the advice he had given them. It was just the practical advice which they all needed, and which he trusted every Member of the Association would lay to heart.

Mr. Seabroke seconded the motion, which was carried with enthusiasm.

Dr. Johnstone Stoney gave an important address on “Observing the Radiants of the Meteoric Streams, and especially of the great

Leonid Swarm," a short summary of which appeared in the November issue of the 'Observatory.'

Mr. Maunder said, with regard to photographing the radiant, if the plates were only to be exposed for a quarter of an hour, it would be quite possible to get perfectly good results with a fixed camera, and so do away with the necessity for a driving-clock. If the observer took the time when he exposed the plate and when he closed it, and noticed also the time when any bright meteor crossed his field, he would have amply sufficient materials for the purpose of reducing his plate afterwards.

Dr. Downing said he had had the good fortune to co-operate with *Dr. Stoney* in the construction of an ephemeris of the densest part of the swarm in the hopes that *Dr. Roberts* would be able to photograph it with his large telescope. *Dr. Roberts* had not yet been able to do so; but the prospects were much more favourable during the ensuing winter.

Mr. Crommelin referred to the discovery of the minor planet DQ made at Berlin about two months ago. What caused, from the first, unusual interest to be taken in it was the very rapid rate at which it was retrograding: it was moving back half a degree a day at the time of its discovery, which showed at once that its orbit must differ in a marked way from the rest of the family.

Dr. Downing said the planet referred to by *Mr. Crommelin* was, he believed, in opposition in the neighbourhood of perihelion in the winter of 1893-94. It must have been a conspicuous object, and the mystery was how it escaped detection at that time. He wished to ask *Mr. Crommelin* whether any photographs of that region taken at the time had been examined.

Mr. Crommelin replied that *Prof. Turner* had offered to examine the Oxford plates, but at present one could not say, within a good many degrees, what the place of the planet was four or five years ago.

Mr. Maunder showed a complete series of slides of the great sun-spot taken with the Greenwich photo-heliograph on the successive days Sept. 3-15. These and some photographs on a very large scale taken with the Thompson 26-in. photographic refractor of the Royal Observatory were shown by the kind permission of the Astronomer Royal.

ROYAL METEOROLOGICAL SOCIETY.

THE opening Meeting of the Session was held on Wednesday evening, November 16, at the Institution of Civil Engineers, Great George Street, Westminster, *Mr. F. C. Bayard, LL.M.*, President, in the Chair.

A report on experiments upon the exposure of anemometers at

different elevations was presented by the Wind Force Committee. The experiments have been carried out by Mr. W. H. Dines and Captain Wilson-Barker, on board H.M.S. 'Worcester,' off Greenhithe. Five pressure-tube anemometers were employed, the first being at the mizzen royal masthead; the second and third at the ends of the mizzen topsail yard-arm; and the fourth and fifth on iron standards 15 feet above the bulwarks. The results show that the ship itself affected the indications of the lower anemometers, while some low hills and trees, which are a quarter of a mile away from the ship to the south and south-west, also affected the wind-velocity from those quarters. The Committee are of opinion that the general facts available from these observations which bear on the situation of instruments for testing wind-force are:—(1) That they must have a fairly clear exposure to be of much value, and that for at least a mile all round there should be no hills, or anything higher than the position of the instruments; (2) That on a ship the results may be considered fairly accurate if the instrument is 50 feet above the hull, but that on land it will generally be necessary to carry the instruments somewhat higher, the necessity being determined entirely by the local conditions; (3) That no other form of anemometer offers such advantages as the pressure-tube, from the fact that it can be run up and secured easily at this height above a building, and that the pipes and stays can be slight, so as to offer no resistance to the wind or cause any deflecting currents.

Capt. D. Wilson-Barber read a paper giving the results of some observations which he had made on board ship with several hand-anemometers, with the view of comparing the estimated wind-force with that indicated by instruments.

Mr. W. Marriott exhibited some lantern-slides showing the damage caused by the tornado which burst over Camberwell about 9.30 P.M. on October 29. The damage was confined to an area of about half a mile in extent, and within that space chimney-stacks were blown down, houses unroofed, trees uprooted, and windows broken.

"The Zodiac explained."

THE Library of the Royal Observatory, Greenwich, contains two copies of an old "paradoxical" book which is probably known but to very few readers, and which, though its main contention is absurd, yet it may be worth while to rescue from oblivion, on account of the interest of the subject of which it treats, and of the soundness of a considerable portion of the argument.

The book is entitled '*Le Zodiaque expliqué*.' It appears to have been written originally in Swedish by—it has been suggested—the Swedish Consul at the "Black City" (Baku), on the Caspian, the celebrated capital of the petroleum district. The

author's name is not given, simply his initials, "C. G. S." The work was translated into French, but the translator's name has not transpired. The first edition appeared in 1807, under the title 'Recherches sur l'origine et la signification des Constellations de la Sphère grecque.' To the second edition, published in 1809, was given the title above quoted, 'Le Zodiaque expliqué.'

The former title is really the more appropriate, since the very first point of the author is that the twelve signs of the Zodiac are intimately connected with the other constellations which have been handed down to us by the Greeks, and that the whole forty-eight form one single coherent document. He points out that some of the zodiacal constellations are very intimately connected with constellations beyond the zodiac. The foot of Ophiuchus, for example, lies in the body of the Scorpion, and the Southern Fish is so closely connected with Aquarius, by means of the stream which he pours out of his ewer, as almost to form one constellation.

The next point that occupies him is the enquiry as to which of the ancient planispheres is nearest to the original. Into this matter he does not go deeply, but concludes that the correspondence between the Greek and Indian planispheres shows that one of them was copied from the other, or both from the same original model. The Phœnicians, who handed down the planisphere to the Greeks, were much less likely to have tampered with it than were the Egyptians.

To confine one's examination simply to the zodiac is unsatisfactory for two reasons. The zodiac by itself gives us no hint as to the date or country of its invention or of its meaning. And zodiacs when treated alone are usually divided into twelve signs of equal length, which have no connection with the actual stellar groupings—a clear indication that these "regular" zodiacs are of much later origin than what we may call the natural zodiac of the Greek sphere, in which the twelve signs are of the most irregular extent, a fact which strongly suggests that some definite idea other than that of pure astronomical utility underlay their conception.

On this point, that the Greek sphere constitutes a real, systematic, coherent document, the author brings forward many arguments. He points out first of all that whilst neither the equator nor the pole star are in any way signalized, the pole of the ecliptic is marked with particular care by the coils of the great dragon. He might have added that the ecliptic is marked as carefully by the twelve signs of the Zodiac, and that these two facts show beyond a doubt that astronomy had already made some progress when the constellations were mapped out, and that astronomical considerations had an important influence in the arrangement of the constellations.

The author next points out that whilst most of the constellation figures are complete, Taurus, Pegasus, and Argo are truncated, a circumstance which can scarcely be regarded as accidental when

one sees what vast spaces of the sky are given up to some of the constellations, such as Hydra, Cetus, Draco, Ursa Major, whilst other constellations, like Sagitta, Delphinus, and the two Crowns, are complete though they have very narrow limits assigned to them. Some of the constellations are seen to be inverted. Pegasus, for example, is a striking case. The stars which compose it could just as easily have been fitted to an erect figure. Nevertheless the Flying Horse races through heaven upside down.

Again, several of the constellations are evidently connected together. Not to refer again to Aquarius and Piscis Australis, to Ophiuchus and Scorpio, we find Orion trampling on the Hare; the Cup and Crow are placed upon the Hydra; Eridanus, the river, flows in its two branches from Cetus, on the neck of which rests the knot of the band by which the two fishes are tied together. This is a point which the author might well have developed much more fully, as the cases mentioned are very far indeed from exhausting the list. The case of the two fishes is, perhaps, the clearest instance of deliberate symbolism in the design, whatever be the meaning to be conveyed. The two fish are represented as being connected by a band attached to rings slipped over their tails. The orthodox explanation, derived from Macrobius, is that Pisces represents the fishing season after the melting of the winter ice. If so it would surely have been as easy, would have accorded quite as well with the stars, and much better with the habits of fishes and fishermen, to have represented the fishes as hooked by the mouth. The neighbouring sign, Aquarius, too, is evidently deliberately planned with some symbolic meaning. As a literal figure, the man pouring a stream of water from a pitcher down upon a fish which does not swim in the water, but which drinks it in, is as absurd as one could well imagine. It is indeed surprising that the design should have been handed down, unchanged, in this form for so many centuries, unless we suppose that some important esoteric meaning was attached to it at the time of its original design.

The next point that the author takes is a very important one, and this also he might have worked out at far greater detail than he has chosen to do. Briefly it is this: though, as we have seen above, astronomical considerations certainly enter into the design of the sphere, yet undoubtedly the idea of enabling observers to recognize individual stars by connecting them with certain imaginary figures was strongly subordinated to other considerations. If astronomical usefulness had been the sole idea, then undoubtedly the constellations would have been arranged to be as nearly as possible of the same size; to be compact, not sprawling; the figures connected with them would have been distinct and without repetition, or, if repeated, repeated only in distant parts of the sky; and most assuredly different constellations would not have been intermingled. Every one of these canons is repeatedly set at naught, and in particular the one which would exclude duplicate

figures. Out of 48 constellations, or if we increase the number by counting the cases in which two or more figures are included in one constellation, out of 54 figures we find twelve men, three women, five fish (these five all close together), two eagles close together, and in immediate neighbourhood to the swan, two bears close together, two dogs close together, three snakes, two crowns, two goats, two streams. The designs that are not repeated are distinctly in the minority, being only 16 out of the 54.

Lastly, composite figures enter into the structure of the Greek sphere. Sagittarius and Centaurus are Centaurs, yet it is perfectly clear that the authors of the sphere did not imagine, like the Aztecs when they saw the Spanish cavalry, that the horse and his rider were one being, for in Pegasus we have a riderless horse. Then the Virgin has wings, though Cassiopeia and Andromeda have not. Pegasus also, like the Virgin, is winged, though the two Centaurs are not. Capricornus is half goat and half fish, though the goat which Auriga carries is of the ordinary character. Lastly, Medusa, the head carried by Perseus has snakes instead of hair.

We think that these considerations are sufficient to show that the ancient constellations were not plotted out at random by a pastoral people who merely saw in the sky the sheep and oxen of their flocks and herds, and the bears and lions against which they had to protect them. There are not a few amongst the star-groups which have a definite dramatic relationship to each other and others again have clearly a symbolical significance. In other words, these old constellations do really form a document, whatever be the interpretation of the hieroglyphics in which it was written.

The next point with which our author deals is the most important. So far as I know he was the first to point out the significance of the space in the southern sky left void of any constellation pictures. I think it was not till seventy years later that Proctor either independently worked out the same idea or borrowed it from some earlier writer. For myself, I learned it, not from Proctor, but from our anonymous Swede. To Proctor, however, belongs the merit of having so placed it before the public as to insure a sufficiently wide recognition of it.

Proctor's deduction was that the sphere was mapped out in North latitude 40° and about 2800 years B.C. A careful examination of the facts of the case leave no doubt, on my mind, that Proctor's date is substantially correct. Our unknown author seems to have been led away by a preconceived idea of the date which he ought to find, and whilst he agrees with Proctor as to the latitude, finds the epoch of the sphere the fourteenth century before our era. The latitude is important as showing that neither Egypt nor Babylon was the original home of the constellation figures. Our author's error as to the date is doubly unfortunate. It causes him to miss the symmetry of the star-pictures with regard

to the colures which the true date brings into evidence, and by compelling him to make an imaginary distribution of the emblems, leads him into a long train of fallacious reasoning. There is only one position in which the actual zodiacal constellations were symmetrically disposed with regard to the colures. This was when they ran through the centre of the four constellations, the Bull, the Lion, the Scorpion, and the Waterbearer, and when the four "royal" stars Aldebaran, Regulus, Antares, and Fomalhaut were as nearly as possible on the equinoctial or solstitial lines.

The date thus found is of interest in many ways into which we cannot enter now. But it at once brings into evidence another circumstance which cannot be accidental and which adds to the proof that the constellations form a single design. The six zodiacal constellations from the summer solstice to the winter solstice—the six descending signs—face one way; the other six—the six ascending signs—face the other.

The place and date show us also that two constellations, and two alone, have been continued by southern or more recent nations beyond their original limits—Argo and Eridanus. These extended to the horizon as they were first mapped out, and have been still continued to the horizon when that extended further towards the South Pole.

A very acute observation occurs early in the second chapter of the book. "It seems very singular that amongst the number of different causes that have been assigned for the origin of astronomy, the need that navigation in the open sea had in the early ages for observations carried on in the stars has almost always been passed in silence. This no doubt comes from the claim that has been made that the Chaldeans and Egyptians were the inventors of this science. M. Bailly, who finds it most natural that all the sciences should have arisen from necessity, has indicated pure curiosity as the mother of astronomy. Its origin has also been attributed to agriculture, which varies not only according to the difference of climates and the nature of productions but also according to the difference of seasons in the same country. Simple shepherds have had the honour of passing as the inventors of this sublime science, probably on account of the Ram which has held the first place among the signs of the zodiac since the intersection of the ecliptic and the equator has been regarded as the point of departure in astronomical calculation. But no one has told us how the attentive observation of the stately progress of the stars from east to west, from sunset to sunrise, could accord with the duties of shepherds who after having wandered the livelong day in the plains and valleys ought in the obscurity of night to relax themselves from their toils and to allow their flocks to rest. Besides the existence of a ship among the constellations is in opposition to everything that could characterize pastoral life.

"But what man is he who watches when all nature sinks to rest; who in the shades of night raises his eyes towards the sky, uneasily

questions the stars, and asks them what course he ought to follow over the vast expanse which offers to his look no point that he can recognize? It is the sailor. His life, that of his companions, their common fortune intrusted to the most treacherous of elements, the wish and hope of increasing their wealth by a rapid voyage, what motives for observation are his, and for observation with diligence and care."

It is curious to note that this reflection, the justice of which no attentive student of the history of astronomy can doubt, leads our author straight to the very heart of his phantasy. It is most probable that, just as we know in modern times the necessities of wider navigation created the demand for a more accurate and more developed astronomy, so in hoar antiquity the first efforts to explore the open sea must have been intimately connected with the beginnings of astronomical science. It is probably more than a coincidence that the reign of astrology, the pseudoscience which fastened itself upon astronomy, and overshadowed it for a millennium and a half, lasted for just the time from the fall of Carthage when the Phœnician empire of the sea passed away, to the age of De Gama and Columbus. The significant fact that the Ram is the first sign in the astrological scheme is sufficient proof that astrology, in our sense of the term, is younger by a sign, that is to say by some 2000 years, than astronomy, which the star sphere shows to have arisen under the Bull.

But to return to our author. Having found his date and place and determining that he must look for a maritime people, excluding Europe from his search as not being sufficiently advanced at so early an epoch, and China as being too distant, he finds himself shut up to the Caspian Sea; and here he finds but one noteworthy harbour, that of Baku: a harbour so important that amongst the Orientals it has given its name to the entire Caspian Sea—*Deria Baku*, the sea of Baku. He then proceeds to argue that Baku having so good a harbour, the country round being so rich in petroleum, the salt-mines in the neighbourhood being important, and the country round being very barren, it followed that the place was a natural seat of commerce, since its people must have imported their provisions in return for which they had abundance of natural products to exchange. Argo therefore, he supposes, has some connection with Baku, and he at once assumes that it must be intended to represent it. If Argo represents Baku, then surely there must be some indication near of the petroleum springs which now and always must have constituted the chief feature of the place. This he finds in the Hydra. "This reptile by the undulating movements of its body and its winding progress very aptly represents the sinuous movements of any liquid which flows slowly. But in order to take away every kind of doubt as to the substance which this emblem represents, the author has joined two other accessory emblems to it, a cup and a crow." A cup, because one can hold naphtha in a cup; and a crow, because crude petroleum is as

black as a crow! Once started upon this system of interpretation, the whole goes merrily forward, and the entire assemblage of the constellations is simply a hieroglyphical map of the countries bordering on the Caspian Sea and lying between the Caucasus and Ararat. Our author supposes that, 1400 years before our era, Baku was the capital of a civilized and prosperous kingdom, a kingdom which has thus given us the constellations, but which, as he naively confesses, has left absolutely no other trace or tradition of its existence.

Our author therefore presents us with a striking example of the true "paradoxez." In the working out of his theory there is much ingenuity and not a little sound argument; but a preconceived idea rules over the whole, and at a critical point he makes an enormous assumption without perceiving that there is the slightest break in the chain of his reasoning. The result is that instead of working up to a sound and useful conclusion he is landed in a bald absurdity. Nevertheless we owe not a little to him. He seems to have led the way in the treatment of a very interesting problem. He anticipated several of Proctor's most ingenious suggestions on this and some allied subjects, even if Proctor did not borrow them directly from him; and I think he has gone far to prove that the old 48 constellations—the Greek sphere—are not a mere chaos of meaningless images, but a single coherent document—expressed, indeed, in hieroglyphics of which tradition has not preserved the key, but possibly not beyond our power to decipher in the future.

E. WALTER MAUNDER.

The Dark Spots in the N. Tropical Zone of Jupiter.

I WAS much interested in reading Mr. Henry MacEwen's letter on the above objects. The longitudes he derived for Spot A, from his observations in March and April, are so considerably *west* of those obtained by other observers during the same period, that it seems highly probable his transits relate, as he infers, to the preceding and broadest end of the spot. But it is singular that on May 29 and June 5 and 7 his longitudes for this object are *east* of those determined by contemporary observers, and yet, as far as is known, the aspect of the spot had not materially changed in the interim. The diffused shading which he describes as involving the spot on March 25 and April 2 was not remarked here, except on very bad nights. When the image was good the spot came out very dark and was sharply bounded, except a little indefiniteness at the *p.* end.

I am afraid that, try as we will, we shall never succeed in eliminating such discordances as those pointed out by Mr. MacEwen, who deserves our thanks for giving his observations in detail, and with the earnest hope that the cause of the incon-

sistency might, if possible, be discovered. None of us are above occasional reproach in work of this kind, and it seems natural, when the circumstances are considered, that large errors must sometimes creep in. In recently combining and comparing a great number of transits of Spot A, I was surprised at the differences apparent in the results of some of the observers. These were no doubt due in a measure to the various and varying conditions under which the work was prosecuted. Transits were sometimes taken of objects scarcely visible in definition of the worst class, and in other cases the observers had necessarily to be hurried in their work owing to other engagements. To go into further details as to causes would, perhaps, serve no useful purpose. Even Mr. Gledhill's excellent observations exhibit some anomalies when compared with the figures of other observers. In the following table I have given an ephemeris of the longitude of the Spot A, derived from a mean of the observations by Mr. A. Stanley Williams, the Rev. T. E. R. Phillips, and myself during the month of March and first half of April. I believe I am justified, by the very good general agreement they show, in adopting the mean of the three named as being fairly near the truth. Side by side with this combined average longitude I give Mr. MacEwen's and Mr. Gledhill's figures. The latter, it will be noticed, are never greatly discordant, but they appear to show that for a lengthy period the spot moved at nearly the same rate as the zero-meridian of System II.

Date.	Spot A. Obs. by W., P., and D. λ.	Observations by Mac- Ewen. λ.	Observations by Gledhill. λ.
1898.	0	0	0
March 2	133	..	131
6	132	123.2	132
8	131	..	130
10	131	..	131
12	130	..	131
13	130	117.3	..
15	129	..	132
18	128	..	131
20	128	..	131
23	127	114.9	133
25	126	118.5	132
30	125	121.9	131
April 2	124	119.1	..
4	123	119.0	..
16	120	110.7	..

According to the list in 'Monthly Notices,' vol. lviii. p. 500, Mr. Gledhill placed the spot, on February 22, in λ 130°, while on May 12 it was in λ 111°, so that though nearly stationary rela-

tively to the rate of System II. during the 36 days from Feb. 22 to Mar. 30, the spot gained 20° during the 43 days from March 30 to May 12. The rotation periods shown by it during the two intervals were therefore $9^h 55^m 41^s.8$ and $9^h 55^m 21^s.5$, which is equivalent to a change of 20.3 seconds. This extraordinary acceleration of motion is not, apparently, corroborated by other observations, but I merely refer to it in proof of the statement that it is useless to expect a very close agreement in planetary work, even amongst the most experienced men. In some cases, no doubt, the results of an individual observer having the skill of either Mr. Gledhill or Mr. MacEwen may be more accurate than the mean values derived from several of his contemporaries; but I think that, in discussing materials, we should give each one equal weight (except under special circumstances) and draw our conclusions accordingly.

Spot A was not the only one which induced anomalies, for at the middle of April Mr. Brenner placed B in $\lambda 273^\circ$, which is about 18° east of the position assigned to it by others at the period named. The same observer found Spot C on May 2 in $\lambda 296^\circ$, on June 4 in $\lambda 280^\circ$, and on August 18 in $\lambda 263^\circ.2$ ('Observatory,' October, p. 379). During the first period of 33 days this object appears to have gained 16° on System II., while during the second period of 75 days it gained only $16^\circ.8$. Of course these markings may and do sometimes vary greatly, and at short intervals, in their rates of motion, but I am afraid our observations (mine, just as well as the rest) are occasionally apt to be even more erratic than the behaviour of the spots themselves.

Bristol, 1898, Nov. 4.

W. F. DENNING.

*On the Orbit-perturbations of the Leonid Meteor-stream
since 1890.**

It seems doubtful if the Comet 1866 I. can be re-observed at its next return, as it only presents itself with sufficient brightness in specially favourable perihelion passages. An investigation of its perturbations by the planets would also be of little use, owing to our present imperfect knowledge of its precise period of revolution. Those perturbations are pretty large ones, because, since 1890, the comet either has come, or will shortly come, comparatively near to the planets Uranus, Saturn, and Jupiter. Hence the question presented itself, whether a somewhat considerable change of form of the meteor-stream's orbit might not affect the brightness of the

* Prof. A. S. Herschel has again been kind enough to send us a translation of a valuable contribution to the subject of meteoric astronomy. The original of this article appeared in *Ast. Nach.* No. 3526.

approaching shower of the Leonids by increasing the orbit's distance from the orbit of the Earth. It is with much pleasure, therefore, that I can here present the results of some calculations of those perturbations. They relate actually to the orbit of the comet itself; but they will fairly well apply also to the orbit of the meteor-system. The approximate amount of the perturbation was computed first for the supposed case of the comet's (or meteor-swarm's) passing its perihelion in November 1898; and secondly on the assumption of the perihelion passage occurring one year later.

The *perturbations produced by Uranus* from 1890.0 to 1895.9 were found to be insignificantly small, the comet's nearest approach to the planet having been 5.1 Earth's orbit radii in 1892.7, and they may be disregarded.

The perturbations due to Saturn are far larger, as (for perihelion passage in November 1898) the comet approached nearer to the planet than 0.5 Earth-orbit radius in July 1895. The body of meteors to be expected in November 1899 passed 2.6 times as far off as this from Saturn, and was thus much less deflected from its original orbit-path. The perturbations produced by Saturn I have calculated for this latter case at intervals of 120 days. For this present year's meteor-group, 40 days intervals were used, which are themselves almost too large for a close approximation in that case's calculation, the retrograde motion of the comet causing its relative position with respect to the disturbing planet to change very rapidly. The perturbations produced by Saturn were as follows:—

- (I.) For the meteors of November 1898, during the time from January 1892 to February 1896:

$$\begin{array}{ll} \Delta\omega = + 2771'' & \Delta\phi = + 735'' \\ \Delta\delta = + 2455 & \Delta\mu = - 0.605 \\ \Delta i = + 2454 \end{array}$$

- (II.) For the meteors of November 1899, during the time from January 1893 to January 1897:

$$\begin{array}{ll} \Delta\omega = + 240'' & \Delta\phi = + 466'' \\ \Delta\delta = + 134 & \Delta\mu = - 0.550 \\ \Delta i = + 192 \end{array}$$

The *perturbations produced by Jupiter* are apparently of pretty appreciable magnitude throughout the whole progress of the comet's revolution. This year's group of Leonids approached Jupiter most closely (distance 1.9) in January 1898; and next year's (distance 0.86) in August 1898. The calculations, made at 60 and at 20 days intervals respectively, gave:—

(I.) For the meteors of November 1898, during the time from April 1894 to July 1898 :

$$\begin{array}{ll} \Delta\omega = + 712'' & \Delta\phi = + 53'' \\ \Delta\Omega = + 659 & \Delta\mu = + 0.340 \\ \Delta i = + 108 \end{array}$$

(II.) For the meteors of November 1899, during the time from August 1892 to July 1899 :

$$\begin{array}{ll} \Delta\omega = + 59'.7 & \Delta\phi = + 1'.5 \\ \Delta\Omega = + 63.4 & \Delta\mu = + 0''.346 \\ \Delta i = + 25.2 \end{array}$$

The sums of all the perturbations impressed on this year's and next year's Leonids since 1890 till their times of perihelion passage are thus considerably larger than the secular orbit alterations (see E. Abellmann, *Astron. Nach.* 3516). The node's displacements are +52' and +66' for the two meteor-groups, entailing the corresponding latenesses of 21 hours and 26 hours on the two showers' returns. The changes of the orbit's excentricity and major axis chiefly affect the least distance between the Earth's orbit and that of the meteor-system. Taking the orbit of the Comet 1866 I. as the basis of the comparison, this least distance would then be

In the years 1866, 1898, 1899
Least distance 0.0065, 0.0228, 0.0113 Earth-orbit radius.

A diminution of the meteor-shower's intensity might be anticipated from this enlarged least distance between the Earth's orbit and the hypothetical mean meteor stream's or comet's orbit; but the possibility should not be overlooked that in 1866 the Earth may not have passed through the densest axis of the stream, and that the latter may now, perhaps, have approached the Earth's orbit somewhat nearer.

In his "Note on the Bielid Meteors" (*Astron. Nach.* 3516) it was stated by Herr Abellmann that the precession in time of the Biela star-shower's node by four days, from the 27th to the 23rd of November, had already been ascribed by Herr Bredichin to Jupiter's perturbing action on the meteor-stream from 1889.5 to 1891.5. I may perhaps be allowed to mention here that, in the 'Naturwissenschaftliche Rundschau' of November 5th, 1892, Bd. vii. S. 578, I had, before the event, pointed out this displacement of the node which the Biela meteor-shower had undergone. But I thought it needless to send the note to any leading astronomical journal, in the belief that all assiduous observers of meteors were already fully aware of the displacement now of the Bielid shower's appearance to an earlier date.

A. BERBERICH.

CORRESPONDENCE.

To the Editors of 'The Observatory.'

The Name of Planet DQ.

GENTLEMEN,—

The unique character and singular orbital position of the little planet DQ, recently found by Mr. G. Witt, give the question of its nomenclature more interest than usually attaches to such matters. Of course the selection of a name, by courtesy and the precedent of custom, must be left to the taste and discretion of the discoverer. But it is trusted that he will pardon suggestion with regard to it, since this is a matter that other astronomers may take a legitimate interest in. It is manifest that this little object is destined to play a rôle in our astronomy of very great importance. It opens up, at a stroke, an unexpected and royal road to the problem of the solar parallax, as well as to those of nutation, the Moon's mass, and aberration. Melancholy as the statement may be it will reduce many of the existing discussions of these elements to the value of waste paper, records of futile effort. Prominent as the object is thus likely to become it deserves a good name. I would suggest that of Pluto, and desire diffidently to urge the claims of this gentleman to the distinction. He is the only one of the six children of Saturn whom that unnatural father was unsuccessful in eating or otherwise destroying, who has not yet stood as godfather or godmother to some member of our planetary system. The other five, Jupiter, Neptune, Ceres, Vesta, and Juno, have been worthily assigned, either to major planets, or to the earlier-discovered members of the Mars-Jupiter belt of asteroids. For the use of the later discoveries in this numerous group the list of available female deities has long since been exhausted, and now sweethearts, wives, girl-babies, and even provinces, cities, and towns are jumbled together in our lists of these objects in a ludicrous way. Will it not now assist to a slight return to dignity and sanity of nomenclature to give some of the neglected male Gods a chance, and destroy the unfair monopoly of the *beau sexe* in such matters? This seems a good time to begin. The body in question stands apart from the Mars-Jupiter belt, practically a stunted twin of Mars himself. Moreover there is a certain fitness in the appellation arising from its faintness or invisibility on ordinary occasions. Pluto under his older name, Hades, was the "invisible" or "unknown," the God of Darkness. This invisibility he removes, with the helmet forged for his concealment by Vulcan, when he comes to opposition, shining then as a comparatively bright star, perhaps visible to the naked eye. This helmet, by the way, could serve as his conventional planetary symbol, if one is desired.

The addition of new asteroids to our lists has become such a nuisance that ordinarily the attachment of ridiculous names may

be regarded as one of the helpful influences in discouraging further useless multiplication of these troublesome words of astronomy. But when one is born into the solar system which gives promise of paying for its keep, some attention should be devoted to a proper christening. In the solution of the problems I have indicated Pluto may be counted on to pay handsomely for his board and clothes.

It is hoped that the discoverer will take these considerations, and others which could be urged, into account in his selection of a name for this interesting and important little planet.

16 Craigie Street,
Cambridge, Mass.,
1898, Nov. 2.

Yours faithfully,
S. C. CHANDLER.

Large Refractors of the World.

GENTLEMEN,—

In your list of large telescopes published in June and July I notice an omission of the telescope built by Rutherford and Fitz, and used by R. in taking his fine photographs of Sun and Moon, &c. :—

Aperture : 13 inches.

Focal length : 15 feet 2 inches.

Institution : Rutherford's Observatory, N. Y. City; afterwards (1883) mounted at Columbia University Observatory, N. Y. City.

Makers : L. & M. Rutherford and Henry Fitz.

Date of erection : 1868.

Remarks : Supplied with 13-inch correcting lens (mounted outside visual lens) which shortened focus to 13 feet.

I trust that a note of this correction to your excellent list may be made.

Columbia University, New York.
1898, Oct. 25.

Yours very truly,
J. K. REES.

Comet II. 1861 and the supposed Comet of A.D. 1454.

GENTLEMEN,—

In reference to Mr. Plummer's communication in your last number (p. 420) on Comet II. 1861, perhaps I may be permitted to point out that, five years ago, I fully discussed, in No. 207 of the 'Observatory' (vol. xvi. p. 381), Phranza's description of the supposed comet of 1454, and showed that its probable date was 1450, and that Pingré was mistaken in the idea that it was stated by the historian to have eclipsed the Moon, the fact being that he probably meant only that it passed near the Moon when she was eclipsed. It was after I had come to this conclusion that I discovered I had been long ago anticipated by Kries in vol. xxiii. of the 'Monatliche Correspondenz.'

Mr. Plummer rightly corrects me with regard to the latest observations of Comet II. 1861, as satisfactory determinations of

its place were made at Pulkowa until the end of April 1862 (the last by Winnecke on the 30th), and the results of these are included in Prof. Kreutz's investigation. The reason I overlooked them is because they are not mentioned in Carl's 'Repertorium.' Perhaps it may be worth while to refer to Dr. Schweizer's paper on the comet in *Ast. Nach.* No. 1381 (vol. lviii. col. 195 *), where he gives a set of elliptic elements computed by Herr Sluzki, and remarks that these agree very nearly with Seeling's, "die aus ganz anderen Beobachtungen abgeleitet sind, und sich über einen bedeutend grössern Zeitraum erstrecken. Es scheint demnach allerdings der Comet eine Periode von etwa 400 Jahren zu haben." Sluzki's period is 399.8 years, little exceeding Mr. Plummer's; but Prof. Kreutz's must be preferable, including a longer range of observation.

Yours faithfully,

W. T. LYNN.

Blackheath, 1898, Nov. 7.

The last of the Great Sun-spot.

GENTLEMEN,—

On November 5, 9^h 30^m A.M., on examining the Sun with a 4-inch Cooke refractor, power 60, I was much struck with the appearance of a small, roughly circular sun-spot, situated between the centre and W. edge of the disk, for it might, at the first view, have been easily mistaken for a planet in transit. The spot was isolated, and it had a narrow fringe of penumbra so dark that it was difficult to distinguish it from the umbra. With a tolerably high power it had a very crateriform aspect and one could not help concluding from appearances that it was distinctly an orifice in the solar envelope. On the morning of November 6 the spot had much contracted and was fainter generally. On November 7 it had further declined, being visible only as a small dusky speck, and passed a vertical wire on the eyepiece 8½ seconds after the Sun's W. edge. There were many brilliant sprays of faculæ in the region round about the spot; and well there may have been, for it was situated in the seat of disturbance of the enormous September group, and formed, in fact, the last relic of the great spot. On November 8 and 9 clouds hid the Sun, but the small spot must have been quite obliterated by November 8 if it had continued to close up at the same rate as during the few preceding days, and in any case rotation must have carried it round the W. limb by November 9.

One point which must have impressed itself upon observers was the gradual way in which the spot had contracted since its first presentation on about September 9. I did not obtain any exact measures to determine the rate of its decrease, but taking its semi-

* This paper may have been sometimes overlooked owing to the references to it in the index of that volume erroneously attributing it (both under Comet and under Schweizer) to Comet II. 1862.

diameter as approximately 25,000 miles on September 9, it must have been closing up (between that date and November 8) from margin to centre at the average diurnal rate of about 417 miles.

I secured some good views of two large groups which succeeded that of September and passed the Sun's central meridian on October 28 and November 5 respectively. The latter, at mid-transit, was about 94,000 miles in length. On certain days very dark nuclei were readily distinguished within the borders of the umbrae of the larger spots, and it was remarked that these nuclei exhibited the same ragged or thatched outline as that of the umbrae. The dark nuclei of a large sun-spot often form a conspicuous feature, and I have sometimes seen them in a $2\frac{1}{2}$ -inch O.G. by Ramsden, power 90.

Bristol, 1898, Nov. 22.

Yours sincerely,
W. F. DENNING.

Sunset from a Legal Point of View.

GENTLEMEN,—

It is strange what difficulties legal minds find in expressions that seem quite simple to ordinary people. I should have thought the correctness of your opinion given on p. 314 could not admit of any doubt; yet Mr. Lynn, on p. 339, evidently does not altogether accept it. The whole difficulty that is brought into the discussion on the "time" for lighting up is through the introduction of the word "time," which word does not occur in the Act of Parliament; and you are yourselves not wholly free from this confusion in your note on p. 314. The statement of a fact does not require the use of the word "time" at all, and therefore there can be no need of using the expression "Greenwich Mean Time," or any other particular time. Would not your sentence on p. 314 read more correctly "the legal time of 'sunset' would be the *moment* when the Sun set at the place in question"? If the word "time" be retained in this sentence, it is used in its secondary sense, and not with its primary meaning of "measure of duration."

Mr. Lynn has not taken any notice of your further question "What is Sunset?" I presume that in the answer to this question the matter in doubt can only be one of seconds, and not of minutes. Mr. Lynn can probably tell us whether Almanacs have not given for centuries the sunrise and sunset at various places, and whether the mode of calculation of these occurrences has been uniform; if so, any uncertainty as to the exact moment will only depend upon whether the refraction is correctly known.

Sunderland,
1898, Nov. 14.

Yours truly,
T. W. BACKHOUSE.

[Elaborating our question, which was purposely vague, we ask, Is sunset the moment when the lower limb touches the visible horizon, when the centre is on the visible horizon (as we believe most almanacs assume), or when the Sun is just wholly below the

horizon? This is a matter of more than seconds, as Mr. Backhouse suggests. The question might be further complicated by asking whether the visible horizon should be taken, or the sensible horizon; if the former, how is the refraction to be computed? In this connection it may be mentioned that there is on record an observation of sunset which happened about half an hour later than the computed time.—Eds.]

Two Pairs of Twins.

GENTLEMEN,—

In what follows, the word “twin” is not, of course, used in the sense of simultaneity, or nearly so, of origin, but of correspondence of circumstances such as does not seem to be found elsewhere amongst the planets of the solar system. The one pair is formed by bodies which are, with one exception, the nearest to the Sun in the system; the other by those which, so far as is at present known, are the outermost of all.

Venus and the Earth are so nearly equal in size that their volumes are very nearly in the proportion of 5 to 6, and their masses are in about the same proportion, their densities being nearly equal to each other. It seems probable, too, that their atmospheres are of about equal density. Whether their times of axial rotation are also nearly equal, after all that has been written on that of Venus, it is difficult to express an opinion; personally I feel inclined to subscribe to that of M. Antoniadi, and to consider that the question is not likely to be settled by observation.

The volume of Uranus is to that of Neptune (according to the latest determination of that of the latter, which makes its diameter about 33,000 miles) in the proportion of almost exactly 5 to 6. Their masses are in nearly the same proportion, so that their densities also must be nearly equal, the mean being a little greater than that of water. Their times of axial rotation are not likely to be ascertained positively by observation, though it would seem probable that they rotate, not only much more rapidly than the planets in the interior of the system, but (like the revolutions of their satellites) in the reverse direction, from east to west.

As regards their atmospheres, their masses being so nearly equal, the one about 15, and the other about 17 times that of the Earth, it is probable that their atmospheres also are not very different in density and, whilst of much smaller amount than those of Jupiter and Saturn, considerably greater than those of Venus and the Earth. Whilst on the subject of atmospheric density, I was rather surprised to read in the work * recently published by Mr. N. S. Shaler, Professor of Geology at Harvard College, that the atmosphere of Mars is probably much grosser than our own.

* ‘*Outlines of the Earth’s History: a Popular Study in Physiography.*’ New York, 1898. 8vo.

It is well understood, every indication pointing to it, that the atmosphere of that planet is of much greater rarity than that of the Earth, permitting us to see the surface with distinctness.

Yours faithfully,

Blackheath, 1898, Nov. 2.

W. T. LYNN.

OBSERVATORIES.

[Continued from p. 411.]

MILAN. *Schiaparelli*.—281 measures of double stars were made with the 18-inch refractor, and 140 with the 8-inch Merz. The satellites of Jupiter have also been observed, and Prof. Schiaparelli believes that J. 1. indicates a deviation from the round figure. Geodetic work. Meteorology.

MÜNCHEN. *H. Seeliger*.—With the Repsold meridian circle Herr Oertel secured 8826 observations of 1306 stars. The 10½-inch refractor was used on comets and planets, as many as 65 small planets being observed. The measures of Saturn and Ring were continued. Time service.

POTSDAM. *H. C. Vogel*.—A large amount of spectroscopic work has been done. The surfaces of Mars and Jupiter have been studied by Prof. Lohse. Photometry of stars has been continued by Professors Müller and Kempf, who have also given considerable attention to variables of short period, two of these latter being detected amongst the zone stars. The one in Cygnus varies from 6.57 mag. to 7.38, with period 3.844 days; the other in Vulpecula has a period of 8.0 days, and varies from 6.95 mag. to 7.61 mag. The usual Sun observations have been continued by Prof. Lohse. The work on the astrographic chart under Prof. Scheiner has proceeded uniformly; 781 plates have been taken. Miss Everett has measured 32 plates containing 22,000 stars, which brings up the total to 63,000 stars on 149 plates; these measures are also reduced, and the first volume (20,000 stars) for the catalogue is ready for printing.

STRASSBURG. *Becker*.—The large refractor has been at work on nebulae and comets. The meridian work embraces observations of the Sun and large planets, and of about 1500 fundamental and 1500 circumpolar stars. The altazimuth was in use for latitude variation work. The Sun's diameter was measured on 92 days by Dr. Kobold with the heliometer. The reduction of the zone observations (-2° to -6°) has been continued.

TURIN. *F. Porro*.—The work is mostly meteorological; but the Director travelled to Norway to observe the eclipse of 1896 August.

UTRECHT. *Oudemans*.—An unfortunate year for work, still a mass of measures of variable stars has been secured. Amongst these are δ Cephei, η Aquilæ, Algol, ϵ Aurigæ, ρ Persei, ρ Lyrae.

Drawings of Jupiter were made on 24 nights and a number of transits of spots. Meteors were carefully noted.

VIENNA (*M. Edler v. Kuffner*). *L. de Ball*.—Zone work. Photographic and photometric work, the latter chiefly on variable stars.

ZURICH. *A. Wolfer*.—The surface of the Sun is carefully studied here. The results for the two past years are:—

Year.	Observing days.	Free from spots.	Relative No.
1896	258	5	40.5
1897	270	21	25.9

NOTES.

COMET NOTES.—Brooks' Comet (δ 1898) was a very conspicuous object in November, and, being well placed in the evening sky, a large number of observations were secured.

At the beginning of November, the comet appeared to have a large, ill-defined, somewhat eccentric condensation, which afterwards became more stellar and more central. No trace of a tail appears to have been seen.

The following elements are by Ristenpart from observations on Oct. 21, 27, Nov. 1, 6 (*Ast. Nach.* 3528):—

T	1898 Nov. 23.1931	Berlin M.T.
ω	123° 33' 41"	
Ω	96 20 1	
i	140 21 4	
log q	9.87852	

Ephemeris for Berlin midnight.

R.A.			S. Dec.		R.A.			S. Dec.	
h m			° '		h m			° '	
Dec. 1 ..	18	15 26	11	33	Dec. 9 ..	18	18 20	16	15
5 ..	18	17 4	14	1					

The comet may be visible in the Southern Hemisphere in January and February. Dr. Smart has computed the following ephemeris from the above elements (for Greenwich midnight):—

R.A.			S. Dec.		R.A.			S. Dec.	
h m s			° '		h m s			° '	
Jan. 14..	18	25 36	30	56	Feb. 7..	18	26 12	39	40
18..	18	26 12	32	20	11..	18	25 16	41	16
22..	18	26 36	33	44	15..	18	23 48	42	51
26..	18	26 52	35	11	19..	18	21 52	44	32
30..	18	26 56	36	38	23..	18	19 12	46	19
Feb. 3..	18	26 44	38	9	27..	18	15 24	48	10

Brightness 0.07 on Jan. 14, 0.04 on Feb. 27. .

A faint comet (*j* 1898) was discovered by Chase on Nov. 14. Only two positions have been received, as follows:—

G.M.T.	R.A.	N. Dec.
	h m s	° ' "
Nov. 14.73	10 7 4	22 55 "
24.0520.....	10 21 48.1	23 36 6

A. C. D. C.

MINOR PLANET NOTES.—Seven new planets have been discovered in the past month, as follows:—

Planet.	Date.	Discoverer.	Planet.	Date.	Discoverer.
DU ...	Nov. 8	Charlois.	DY...	Nov. 13	Wolf—Villiger.
DV ...	Nov. 6	Wolf—Schwassmann.	DZ...	Nov. 19	Wolf—Villiger.
DW ...	Nov. 6	Wolf—Villiger.	EA...	Nov. 19	Wolf—Schwassmann.
DX ...	Nov. 6	Wolf—Villiger.			

They are all of the 12th or 13th magnitude.

The following planets have received permanent numbers:—

Planet.	Date of Discovery.	Discoverer.	Number.
DL	1897 Nov. 23	Charlois	429
DM	Dec. 18	Charlois	430
DN	Dec. 18	Charlois	431
DO	Dec. 18	Charlois	432
DQ	1898 Aug. 13	Witt	433
DR	Sept. 11	Wolf	434
DS	Sept. 11	Wolf—Schwassmann	435
DT	Sept. 13	Wolf—Schwassmann	436

The planet DP, discovered by Charlois 1898 July 16, does not receive a number, not having been sufficiently observed.

Three new orbits of the planet (433) DQ have been published, two by Millosevich, and one by Prof. Hussey; we only give Millosevich's second orbit here, as it represents all the observations from Aug. 4 to Nov. 3, with no error greater than about 1 sec. of R.A., while the error of Berberich's ephemeris on Nov. 3 was +52".16 (obs. R.A. — Tab.), that of Millosevich's first elements —12".82, and that of Prof. Hussey's —12".11.

The following are the new elements (deduced from observations on Aug. 14, Sept. 21, Oct. 24):—

Epoch 1898 Aug. 31.5 Berlin M.T.

M	222° 16' 27".1
ω	177 13 32.6
ϖ	303 27 48.3
i	10 48 33.5
π	120 41 20.9
ϕ	12 52 48.3
μ	2012".2186
log a	0.164221
Period	644 ^d .0653
Perihelion distance	1.13421.

It will be seen that the difference between this orbit and that of Berberich is very slight, and would scarcely be noticed on the scale of the diagram given in October.

The planet will be in perihelion 1901 Feb. 7·93, while the Earth passes the longitude of its perihelion 1901 Jan. 20·93, just 18 days earlier.

The brightness during December only diminishes slowly, for the planet, though receding from the Earth, is rapidly approaching the Sun. Hence it will probably be observable throughout December. The following ephemeris, for Berlin midnight, is from the above elements:—

1889.	R.A.			Dec.	1898.	R.A.			N. Dec.
	h	m	s	°		h	m	s	°
Dec. 3..	21	50	56	1 23 S.	Dec. 19..	22	23	55	1 15
7..	51	58	48	0 47 S.	23..	22	32	46	2 0
11..	22	6	57	0 8 S.	27..	22	41	49	2 46
15..	22	15	19	0 32 N.	31..	22	51	4	3 35

Perihelion passage in 1894 took place Jan. 18·67, while the Earth passed the longitude of its perihelion Jan. 20·23, or 1·56 days later.

There will not be an equally favourable opposition till 1961; the following are the approximate dates of the most favourable perihelion passages after that of 1901:—

1916 .. Dec. 22.	1938 .. Feb. 19.
1924 .. Jan. 10.	1961 .. Jan. 20.
1931 .. Jan. 30.	

Ristenpart gives in *Ast. Nach.* 3527 an ephemeris for a perihelion opposition based on Berberich's elements, which we give, as it illustrates the very singular apparent motion, which is almost at right angles to the ecliptic:—

1893-94.	R.A.			N. Dec.	1894.	R.A.			Dec.
	h	m	s	°		h	m	s	°
Dec. 4....	8	20	38	54 29	Feb. 6..	8	20	10	0 37 N.
20....	8	48	57	50 8	22..	8	25	6	11 48 S.
Jan. 5....	8	52	13	39 43	Mar. 10..	8	28	23	17 5 S.
21....	8	36	18	21 1					

This ephemeris will serve as a rough guide in the examination of photographs taken in January 1894 for traces of the planet; it should, according to Millosevich, be increased 17^m in R.A., 4°·3 in declination, for that opposition.

Prof. Pickering, in Harvard Circular No. 34, gives the result of a series of visual and photographic measures of the stellar magnitude of this planet. He makes the visual magnitude (at $r = 1$, $\Delta = 1$) 11^m·39, and the photographic 11^m·99. Other observers have estimated the magnitude as 0^m·6 to 0^m·9 brighter than that given by Prof. Pickering. If we accept his figures, the brightness

at a perihelion opposition will be about $7^m.5$. He points out that this planet will afford an excellent test of the law of inverse squares for the transmission of light through the solar system, and on account of its large phase when in quadrature in perihelion it will also afford the means of testing the amount of variation of light due to phase.

The planet (434) *Hungaria* would have attracted more attention if it had not been discovered just after (433), for, with that exception, its mean distance is much less than that of any other member of the group.

Dr. Berberich gives the following elements in *Ast. Nach.* 3525 :—

Epoch....	1898 Oct. 10.5	Berlin M.T.
M	58° 46' 13".8	
ω	123 10 7.2	
Ω	174 37 56.0	
i	22 33 38.1	
ϕ	4 14 43.5	
μ	1306".439	
$\log a$	0.289278	

The following table gives all the minor planets whose mean daily motion exceeds 1000" :—

μ .	Planet.	
2012".....	433	
1306	434	
1175	330 (uncertain)	
Between 1120" and 1100" ...	323, 149, 244	} Each group is in the order of diminishing mean daily motion.
" 1100 " 1080 ...	281, 352, 254, 270, 341, 8, 228, 43	
" 1080 " 1060 ...	422, 367, 291, 364, 296	
" 1060 " 1040 ...	315, 336, 298, 72	
" 1040 " 1020 ...	40, 207, 136, 317, 376, 18, 80	
" 1020 " 1000 ...	326, 391, 370, 345	

The perihelion distance of (434) is about the same as the aphelion distance of (433). There are several members of the group that have smaller perihelion distances in consequence of their larger eccentricities.

A. C. D. C.

OBITUARY.—We regret to announce the death of Mr. Edwin Dunkin, F.R.S., a former President of the Royal Astronomical Society, and Chief Assistant at the Royal Observatory, Greenwich, from 1881 to 1884, who died at Blackheath on Saturday, November 26, aged 77 years. We hope to give an adequate notice of the life of Mr. Dunkin in our next number.

The death-roll for the past month includes the name of Sir George Baden-Powell, M.P., K.C.M.G., who, it will be remembered, took a party of astronomers (the only successful English expedition) in his yacht to Nova Zembla to observe the total solar

eclipse of 1896 August. Sir George, who was the son of the Rev. Baden-Powell, Savilian Professor of Geometry in the University of Oxford, died at the comparatively early age of 51.

On Sunday, October 30, Mr. Latimer Clark, F.R.S., died suddenly at Kensington. The deceased gentleman, who was in his 76th year at the time of his death, was distinguished chiefly as an electrician. He was a Fellow of the Royal Astronomical Society, and the author of an elementary book on the transit-instrument.

THE LEONID METEORS.—The expected meteor-shower was a little disappointing. Very unfavourable weather prevailed over the country at the time, but, apart from that, at stations where the sky was clear at times when meteors were expected very few were seen. At Greenwich only a short opportunity of observation presented itself, and one Leonid was seen about 11^h 15^m on the evening of November 15. From an Article by Mr. Denning in 'Nature' of November 24, we gather the following information :—

Place.	Observer.	Clear sky.	Result.
Belfast	Milligan	Nov. 12 until 15 ^h 30 ^m 13 until 15 30 14 16 ^h 40 ^m —17 ^h 15 ^m	No Leonids. 6 meteors; 3 Leonids. 10 fine Leonids.
Southport	Baxendale	14 13 30—17 30	30 meteors, nearly all Leonids, but small.
Yeovil	Phillips	14 13 0—15 0	2 or 3 meteors.
Cirencester ...	Miss Brown	14 11 45—12 50	No meteors.
Gateshead	Blacklock	13 10 0—15 0	No meteors.
Northants	Wright	14 12 0—15 0	A brilliant meteoric flash at 13 ^h 55 ^m .
Bristol	Denning	12 15 0—17 0	7 meteors. No sign of radiation from Leo*.
Chester	Longbottom	16 10 0—13 0	A Leonid of the brightness of Mars, and a Perseid.

Prof. Young, of Princeton, writes to us under date Nov. 15 :—
 “Last night we had a feeble but distinct Leonid shower between 3^h 15^m and 5^h A.M.† Professor Reed and I, part of the time together and part separately, observed about a hundred. About a dozen were as bright as 1st magnitude stars or brighter; the rest were mostly faint; all of them had trains, visible from 1 second to 10 seconds. The maximum was about 3^h 45^m A.M., when for about 20 minutes the meteors averaged two or three a minute. The

* At 16^h 4^m the sky was illuminated, probably by the outburst of a large meteor in a region of the heavens hidden from the observer.

† November 14^d 20^h 15^m—22^h 0^m G.M.T.

radiant appeared to be rather indefinite, but I estimated its centre to be nearly in R.A. 151° , Dec. $22\frac{1}{2}^{\circ}$.

"A striking feature of the sky, which was beautifully clear at the time, was the brilliance of the zodiacal light, which at 5^{h} A.M. extended from the S.E. horizon fully 80° up to the planet Mars, now close to Præsepe. The night of November 13-14 was rainy, so that we obtained no observations."

A correspondent writes to us from Machrihanish Observatory, Campbeltown, N.B.:—"Watched with camera ready on Nov. 14 from 10^{h} to 16^{h} G.M.T., but the sky was covered with greasy mist. After giving it up as hopeless, a few were seen about 17^{h} . A collier going to work was so startled by a short but brilliant outburst that he snatched his cap from his head and threw it down, thinking his head was on fire."

Prof. Alex. Herschel kindly sends us an extract from a letter from his nephew, Mr. Hardcastle, who observed from Alassio, on the Riviera coast. Mr. Hardcastle writes:—

"Morning of the 14th cloudy; of the 15th I watched from 2^{h} to 3^{h} ; my friend Baroni was up from 3^{h} to 5^{h} , and I was again on the look-out from 6^{h} to $6^{\text{h}} 30^{\text{m}}$ A.M. The numbers were quite remarkably constant—30 *per hour*. I did not plot the tracks, but referred each to its apparent radiant as it appeared, with result that the radiant-area seemed to fill the sickle; and two very bright ones came from well behind, their lines being from β Leonis up to α , u , p , r Lyncis. Also one came from somewhere on the ecliptic preceding Regulus."

Prof. Herschel adds:—"The duration of this watch kept by Mr. Hardcastle and Signor Baroni (a very able Member of the Italian Meteor Association) was from 1^{h} A.M. to $5^{\text{h}} 30^{\text{m}}$ A.M. Greenwich Time, on the morning of November 15th, and as the display was plentiful and constant in hourly numbers during all that time, and as towards the end of the watch its description is perfectly confirmed by a well-caught view of the shower seen at Belfast from 5^{h} to 6^{h} A.M. G.M.T. on the 15th by Mr. W. H. Milligan, who writes to me that, allowing for the mist and gas-lights in his field of view, through which he was yet able to count ten meteors in 35 minutes, the probable rate of their appearance for a clear sky would be about 25 per hour, and their greatest frequency at about the middle of that time, it seems evident that a long-lasting side-stream of the Leonid meteor-system, not quite so intense as the same side-stream's display in England on the morning of November 13th, 1865, was really passed through at just the indicated time of such a side-stream's occurrence, which would be deduced from this year's predicted time for the main stream's reappearance. It will be an interesting further confirmation of the correctness of the time prediction if it should soon appear from other foreign observations that an equally notable exhibition of Leonids was visible on the morning of November 16,

as a cloudy wind with rain, which had set in the previous evening, rendered the sky in England on that night quite unfitted for observing them in this country."

THE BIELA METEORS.—No more success appears to have attended the observation of these meteors than it did that of the Leonids. At Greenwich instructions were given to the observers to keep careful watch for these from the night of the 21st; but cloudy skies made observation impossible. At present we have heard of no meteors of the shower having been seen.

LARGE VELOCITIES IN THE LINE OF SIGHT OF CERTAIN STARS.—Prof. W. W. Campbell, of the Lick Observatory, publishes in the 'Astrophysical Journal' for October some results of his spectrographic determinations of stellar motions. After correcting his results for solar motion, which he assumes to be towards the point R.A. = 267° , $\delta = +31^\circ$, with a velocity of 17 km. per second, he finds the velocity with reference to the sidereal system to be as follows:—

η Cephei	—74.1 km. per sec.
ζ Herculis	—53.9 " "
The planetary nebula G.C. 4373 ..	—50.9 " "

The result for ζ Herculis is in close agreement with that found by Prof. Belopolsky. The velocity of the nebula found by Prof. Keeler was —64.7 km. per sec.

VELOCITY OF η PEGASI.—In the same publication Prof. Campbell gives some similar measures for η Pegasi, which appears to have a variable velocity: on 1896, Aug. 27, the velocity was +7.1 km., on 1897, Sept. 28, —2.2 km., on 1898, Sept. 4, +16.5 km. per sec. Intermediate values are consistent with these, which seem to show a period about 2 years in length.

MR. McCLEAN'S STAR-SPECTRA.—We have received a handsome present from Mr. Frank McClean, F.R.S. He has sent us a copy of his Memoir on the Comparative Spectra of Northern Stars, which forms part of Vol. 191 of the 'Philosophical Transactions,' and a copy of his similar Memoir* on Southern Stars, which gives the result of his work at the Cape in 1897, and completes

* Published by Edward Stanford, Charing Cross, S.W. Price 1s.

the spectroscopic survey of stars to the 3rd magnitude, for both the northern and southern hemispheres. This work was adequately reviewed by Mr. Maunder in our number for April last; we have only to add here that the photographic spectra of all the stars are here excellently reproduced, and placed as they are in groups, side by side, the casual inspection of them compels the interest even of the non-spectroscopist. We congratulate the author on this monumental work, and thank him for his gift.

AN Atlas of Variable Stars is being prepared by the Rev. J. G. Hagen, S.J., based on manuscripts left by the late Mr. Pogson. The plan of the work seems to be that a chart 30' square is devoted to each star whose variability is well-established, which lies between 0° and 115° polar distance. Each chart shows clearly the field about the variable, so that there will be no difficulty in identification, and the maximum and minimum brightness is indicated. The atlas will be divided into five series: its expensive publication is being aided by Miss Catherine Bruce, and astronomers will be therefore able to buy the whole series at the comparatively small price of 1 mark per chart, or 1.20 marks if they take only one series. Intending subscribers should communicate with Mr. Felix L. Dames, Berlin W., 62 Landgrafenstrasse 12.

IN Wolsingham Circular, No. 48, Rev. T. E. Espin reports that a star, mag. 8.4, Type IV., not in the B.D., was found on Nov. 13 in R.A. $4^{\text{h}} 19^{\text{m}} 49^{\text{s}}$, Dec. $+39^{\circ} 32'$ (1855.0). Also that the star in the Andromeda nebula (recently announced by Seraphimoff of Poulkova) was seen on Nov. 10 closely following the nucleus. The one found at Wolsingham in 1886 was preceding.

With regard to this star in the Andromeda nebula Prof. E. C. Pickering writes, in *Ast. Nach.* No. 3526, that photographs of the nebula taken on 1898, Sept. 20, 21, and also similar photographs taken in 1893, 1894, 1895, and 1896, fail to show any stellated appearance.

THE Copley Medal of the Royal Society has been awarded to Sir William Huggins. Dr. Johnstone Stoney is a member of the Council for the ensuing year.

A PARTIAL Eclipse of the Sun will happen on December 12, which is of little interest, as it will be visible only from the South Pacific. On December 27 there will be a Total Eclipse of the Moon, visible at Greenwich. The circumstances and list of small

stars which will be occulted during the eclipse are given in the 'Companion' for the current year.

WE have received from Mr. W. Peck an account of the formal opening of the Calton Hill Observatory, the City of Edinburgh Public Observatory, which took place recently, with a history of the institution and a series of photographs. We have not space to deal with this in this number, but hope to do so at a future date.

FROM AN OXFORD NOTE-BOOK.

THE Leonids and Andromedids were both disappointments. We sat up all night, and had a patrol watching for breaks in the clouds, but not a rift appeared, and our only consolation was the lunch at 3 A.M. (Not knowing what to call this meal, I adopt the convenient American term for any irregular meal.) The cloudy weather was a disappointment in more ways than one, for I wanted to know the event of an experiment made by the District Messenger and Theatre Ticket Company :

To a 'Daily Mail' representative who saw him yesterday Mr. Lord gave some particulars of the idea.

"You see," he said, "I was struck by the interest which seemed to centre in this promised shower of meteors, and as our offices are open night and day, and we have boys moving about London at all hours, I thought if any one was likely to know of the expected happening, we should.

"The boys who are on 'night watch,' and visit certain premises every half-hour during the night, have accordingly been instructed to keep their eyes open and look out for shooting stars. If they see any they will report to the office immediately, and those persons who have expressed a wish to be called will be promptly rung up.

"The charge for this disturbance of one's beauty sleep is 6d. if the house is within half a mile of an office, and 1s. for longer distances. In the event of no show taking place the money, taken when the order is given, will be refunded, less a small deduction for booking.

"It does seem rather a curious scheme," remarked Mr. Lord, "but it was meant to supply a public want, and the fact that orders have been given for the service at a number of our offices shows that people are interested.

Now it is one thing to give an order to be rung up, and another thing to get up when rung ; and I should have liked to hear what was said to the boys if the meteors *had* come. If the experiment is repeated next year, I hope the boys will be supplied with a note-book and a (blue ?) pencil.

BUT if the messenger-boy why not also the telegraph ? It would be an excellent plan if news about the meteors could be exchanged between (say) Europe and America. Some years ago Prof. D. P. Todd took some trouble to organize telegraphic communication between distant stations for observations of the same total eclipse. There might be greater advantages still in putting

meteor observers into constant communication. The companies are usually well-disposed to cable scientific enterprises of this kind ; has anyone time to put some plan into working order before next year ?

THE Royal Astronomical Society will, at their next Meeting, take a new departure in the election of Associates. The Associateship has been hitherto a distinction conferred on foreigners, who were, by the nature of the case, not already Fellows. But a welcome anomaly has sprung up in recent years of electing foreigners (I fear we must include our American cousins even under this head) as ordinary Fellows. I don't quite know who began it, but the breaking of the old rule has been a success ; it has given us many eminently desirable new Fellows, and has not so far been attended with any disadvantages save one, viz., that some of those next on the list for the honour of being proposed as Associates were already Fellows, and the Council did not know quite what to do in such cases. This difficulty has stopped any additions to our list of Associates for some years past, the last elections being Michelson and Poincaré in 1894. But the Council ultimately cleared the way by voting on the definite question, " Was ordinary Fellowship a disqualification for Associateship as well ? " and settled it in the negative, to its own manifest relief. So there will come up for ballot on December 9 next the names of seven distinguished astronomers, three of whom are already Fellows of whom we are justly proud, viz., Barnard, Burnham, and Keeler.

It is remarkable that of our 37 Associates, three have enjoyed that distinction for more than 50 years ! Faye, Galle, and Otto Struve were all elected Associates on 1848, May 12, and to the last-mentioned I am indebted for calling my attention to the fact. There is another " triple star " 18 years later, Auwers, Förster, and Safford having the common date 1866, May 11 ; and between these dates there is only one name, Luther, of Düsseldorf, in 1854. After the second trio come a quartette—Janssen, Newcomb, Schiaparelli, Young, of date 1872, November 8 ; and then we pass gradually to comparatively recent years. But the veteran trio of a half-century is the more remarkable when we look at our list of Fellows, and find that only 7 names out of the 600 odd have an earlier date of election, the father of the Society being James Glaisher, 1841, May 14.

THE simple ceremony of admitting Fellows, either in person or by proxy, at the Meetings of the R. A. S. is too well known to

need explanation; but I wonder if anyone will recognize it as described in the 'Gloucester Journal' of November 19, 1898:—

Mr. William Johnston, 152 Wotton Hill, Gloucester, was elected a Fellow of the Royal Astronomical Society at a full Meeting of the Fellows on January 8, 1897, in recognition of most important and valuable contributions to Astronomical Science and original works on Dynamics and Sidereal Astronomy. Mr. Johnston has frequently since then been invited to meet the Fellows at Burlington House, and on Friday last Professor Turner, M.A., F.R.S., Savilian Professor of Astronomy in the University of Oxford, representing Mr. Johnston by proxy, presented him to the President, Sir Robert Ball, M.A., F.R.S. The Astronomer Royal, Mr. W. H. M. Christie, F.R.S., Admiral Sir Erasmus Ommanney, O.B., F.R.S., Dr. Stoney, M.A., F.R.S., &c., with some 50 Fellows, were present, and Mr. Johnston's works were spoken of in the highest terms of congratulation and approval. The reception which followed was numerously attended, and much regret was expressed that Mr. Johnston was not able to be personally present.

On investigation, Mr. Johnston turns out to be a regular paradoxer, and though naturally desirous of admission into the Royal Astronomical Society, was clearly not a "proper person to become a Fellow thereof." However, three gentlemen who ought to have known better said he was, and so he got in. It would, perhaps, be rather cruel to give the names of his sponsors here; but it is too good a joke not to be told that one of them is constantly protesting against the election of Fellows who *advertise themselves*.

An old and nearly disused method in the Planetary Theory is lifting up its head again. A paper by MM. Perchot and Ebert in the 'Comptes Rendus' for October 10 gives, in an explicit form, the integrals of the restricted problem of three bodies, to the first order of the disturbing mass. This idea of finding successively the terms of different orders in the disturbing masses was the basis of the old method of absolute perturbations, which was superseded by the theory of variation of arbitrary constants towards the end of the last century. MM. Perchot and Ebert obtain the integral by using Jacobi's Principal Theorem; but their result is substantially the absolute perturbation of the first degree. For this interesting remark I am indebted to Mr. E. T. Whittaker, of Trinity College, Cambridge, who is writing a British Association Report on Planetary Theories, and thus knows a good deal of the history of the subject just now. From other remarks he made I fancy we may hope to have something from his pen on this disused method, which he considers of the highest importance theoretically, though practically the method of variation of arbitrary constants is much better.

We may hope, during the next six months, to have before us the hitherto unpublished work of the late Prof. J. C. Adams. The
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previously published papers were reprinted in the volume which has already appeared; in the volume shortly to be published will be the other astronomical work, edited by Prof. R. A. Sampson, of Durham, and the work on the Gaussian Magnetic Constants, edited by Prof. W. G. Adams. The former part was printed off some weeks ago, and the volume is only waiting for the magnetic work, of which Prof. W. G. Adams gave a summary to the British Association at Bristol. Prof. Sampson has kindly allowed me to see a copy of his portion. It is disappointingly brief (240 pages), but the same would have been said of ten times the quantity from Adams. Especially is this the case with the long-looked-for work on Jupiter's Satellites, which occupies 68 pages, with the following prefatory remarks:—

Lectures on the Theory of Jupiter's Satellites were given in 1878 and again in 1880. They included matter which did not differ from Laplace, and this has been omitted. Moreover, as it did not seem to add to clearness to preserve the division into lectures, what remained, that was original and characteristic, has been cast into the form of three essays.

As an account of the whole problem these are incomplete in detail, and would require much development before they could be applied to such questions as the determination of the masses and other constants from observation; but they are of interest because they seem to indicate some outlines of the plan upon which Adams would have attacked the entire problem.

But though the quantity is disappointing the quality of the work is what we might expect. The lectures on the Lunar Theory present the theory in the attractive form of special problems each solved with wonderful completeness by the use of simple apparatus; they occupy 84 pages. Other papers give some details of work done by Adams of which he only published the results or a brief summary—*e. g.*, the perturbations of the orbit of the November meteors.

THERE is a curious point in connection with this paper on the November Meteors, published originally in the 'Monthly Notices' for 1867 (April), which was reprinted in the volume for 1897 (March). Herr Abellmann says (Ast. Nach. 3516) that in a separate reprint of the original paper which he found in the Pulkowa library, it is stated that the computations were made by dividing the orbit into 12 parts, "which statement is omitted in the recent reprint (1897 March)." The statement is omitted, or rather does not appear ("fehlt"), in the 1897 reprint because it is not in the original paper as printed in the 1867 volume. I imagine it must have been added by Adams in the separate copies distributed, of which the Pulkowa copy is one. But now comes the curious thing; in the abstract of the actual calculations furnished by Prof. Sampson, the orbit is divided into 13 parts,

It is worthy of remark how few are the astronomical references in everyday reading. Take, for instance, a charming book to which I had not time to do justice (it contains 500 large pages), the 'Memoirs of a Highland Lady,' edited by Lady Strachey (John Murray, 1898). All sorts of things are told us about all sorts of people by a keen observer, and the record extends from 1797-1830; and yet there are only two places where passing reference is made in half a dozen lines to anything astronomical. This is all the writer has to say of the great comet of 1811:—

This was the year of the great comet; night after night we watched it rising over the town of Ramsgate, spreading its glorious train as it rose, and then passing slowly on, the wonder of all, and terror of some, a grand sight only equalled by the northern lights as we used to see them in the Highland winters.

In 1827 the writer went a voyage to India, and says:—

After crossing the Equator we found a charming occupation—a map of the southern sky. The constellations were so beautiful: we have no idea in these cloudy climates of the exquisite brilliancy of the cloudless ones, the size of the stars, too. We marked each as it rose, often staying on the poop till actually ordered away. The Cross, Sirius, Aldebaran—never were such diamonds in a sky.

This passage is open to criticism, but is not written to be scanned too closely. On looking through the index there seemed to be a third reference under the head "Sir Philip Dirom's Star," but this turned out to be merely a decoration, of which the owner was very proud, and concerning which "Lord Lauderdale laid a bet that Sir Philip would not be two hours in the house without producing it: nor was he."

A VERY pretty little investigation by Father Schreiber on the going of a clock appears in *Ast. Nach.* 3526. He found that there was a regular weekly variation in the rate, which, as a first step, naturally connected itself with the fact that the clock was wound up once a week, every Wednesday morning (not Saturday night as in 'Tristram Shandy'). The weight in its descent passed near the pendulum bob. Did it influence the bob by attraction? The magnitude of the effect seemed against this view, and Father Schreiber was more inclined to suspect the pressure of the air compressed between weight and swinging bob. As a test he put a card tube in the place where the weight was closest to the bob, and was gratified to find the change of rate exactly reproduced. He suspects, and with good reason, that other clocks may be similarly affected, but cannot find many records suitable for analysis. In the case of the clock Hardy used at the Cape 1879-1883, however, he ventures to guess, from the record of its going, that it was wound once a fortnight, and I shall await with interest the con-

firmation or refutation of this surmise. Altogether a neat little paper, raising an important and (so far as I know) novel issue.

FROM a Transatlantic friend I received, the other day, a copy of the 'Zodiac of the Human Face.' "Man," it appears, "is the microcosm of the macrocosm, *e. g.* he is the miniature copy of the Great Plan of Kosmos, which is expressed and registered in the zodiac, and stamped indelibly and mathematically in the face of man." The twelve signs of the zodiac are thus found in the human face; Libra is the mouth, Taurus the chin, Sagittarius the nose, &c., &c. Thus:

Suppose we find a strong, large, well-formed *chin*, which is the only well-formed feature in the face, we know the Sun was, at birth, only a few degrees in the sign of Taurus.

And lower down we read that Taurus

represents ability in mathematics or the legal profession, good intellect, noble and hopeful, high positions, some defeats in financial matters, independent and physically strong; inclined to throat-affections, quinsy, &c.

On the whole not an undesirable "fortune." I was meditatively feeling my chin to see what claims I had to it, when it suddenly struck me that, whatever size my chin was, my birthday was as a matter of fact in quite a different sign, unless I have been wilfully misinformed; and looking under the correct sign I find

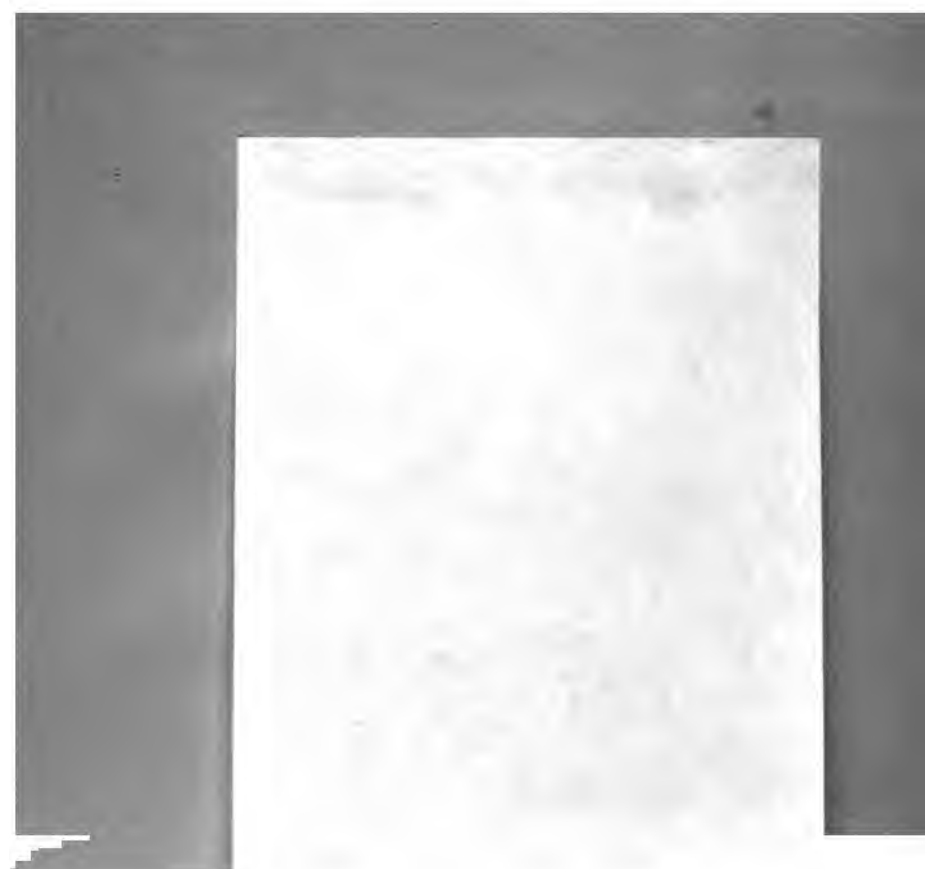
Violent, passionate, vain nature, capable and successful, adventurous and warlike, taste for art, faithful to friends, fond of rule and authority; inclined to affections in the sides and ribs, palpitation of the heart.

What makes me sceptical about this being right is that I have as yet had no signs of "affections in the sides and ribs." Each of the twelve "fortunes" has a specific physical disability; there is one under Aquarius which would suit me personally much better than rib-affections, at any rate at this season of the year when hockey is played, viz., "inclines to accidents and affections of the legs and ankles." But is it not asking a good deal that all hockey and football players should be born under Aquarius?

STRANGE enquiries are sometimes made of astronomers—as when a simple farmer wrote to ask the Astronomer Royal how many piglings his sow would farrow next time; so that one ought to be prepared for the unexpected. But I am puzzled by the following query which has just come to hand from Canada:—"I should be obliged if you will have the goodness to advise me where I can dispose of the following medals which I collected from the Chippewa Indians in the Dominion of Canada, viz., 3 Prince of Wales' Medals of 1860, silver, size 3, &c., &c."







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